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MODERN STEREOTYPY, AND THE MECHANICS OF THE NEWSPAPER.

BY

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[The extraordinary speed attained in the production of a modern newspaper is not alone due to the very perfect design of the presses and their high degreee of refinement. The press-work constitutes but the final operation of several important steps. One of these is the manufacture of stereotype plates or replicas of the type-composition which are bent to a cylindrical form for use in the modern high-speed rotary press. Upon the perfection of these, much of the excellence of modern newspaper press-work depends. The author reviews the growth of the art in keeping pace with modern needs and describes in detail how the solution of the problems encountered in its development has evolved the modern perfected autoplate process.]

GENTLEMEN: I am deeply conscious of the fact that you have paid me a high honor in asking me to address you here to-night. Standing in this old hall, in this revered birthplace of the idea of the Centennial Exposition, pregnant as was that idea with the most stupendous impetus that a single event has ever given the utilization of the stuff and habits of the physical world, I am abashed. When I compare with its quaint and simple architecture and its homely and primative accessories, the elaborate edifices of to-day, filled and throbbing as they are with the innumer-

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able, intricately organized, man-serving devices which, during the passage of but a single generation, have come to so multiply our powers, our comforts, and our pleasures, I am astonished. And when I recall that so much of this progress was born of inspiration supplied by that great mother of physical inquiry, the Franklin Institute of the State of Pennsylvania, it is indeed difficult to believe that in the short span of her life the practice of the science of physical inquiry should have accomplished so marvellously much.

But a single thought saves me from confusion: that he for whom this institution was named, whose boundlessly liberal and truth-seeking qualities have become its fundamental traditions, was once a printer. Thus I am assured that whomsoever may since have labored to extend the usefulness of the typographic art, however humble his addition to the sum of its knowledge, may in the name of the illustrious Franklin here claim the protection of the ægis of an especial tolerance, and freely speak his mind.

If the spirit of that wise and genial philosopher could be recalled to earth and shown all of the progress since made by mankind, it is not difficult to name the branch of human endeavor in which he would find the most at which to wonder. Human nature is but where Poor Richard's philosophy found and left it; the slow evolvement of successful government has been carried but a sorry step further than it was at the sitting of the Constitutional Convention; the advent of an unarmed peace between peoples, the possibility of which has ever seemed to so many to hover but just beyond the horizon, appears but little nearer than in the days of the surrender at Yorktown; while the things that are new in literature, in art, in pure philosophy are so infinitesimal when held against the glorious background of the past as to fade to utter insignificance.

In what, then, has the world changed? What is the new mode of thought, strange in Franklin's day, that has since entered the consciousness of the race and become, of all its implements, the most serviceable? *The will to test all things,* is a brief but comprehensive answer. And it is with some of its fruits, as expressed in one phase of human activity, that we shall later be concerned to-night.

During Franklin's life a dry, a curious, a but little understood

collection of fragmentary information concerning physical phenomena composed a suspected and half-proscribed thing, called science. Into this mysterious realm men had already begun cautiously to peer. At first it seemed unrelatable to their daily lives. But into it gradually they grew boldly to look, and new applications of natural phenomena to desirable human ends began to be made. Then slowly, but with an ever increasing breadth of field and rate of development, physical science became the means through which man has since so wholly been able to readjust, upon infinitely more favorable terms for himself, his relations with nature and his fellows.

In this recent application of his thought to the discovery and comprehension and use of the materials and habits (miscalled the laws) of nature, lies the means by which man has been able the more securely and comfortably to seat himself in the chariot of life, the more widely to extend the path of its flight, and the more economically and beneficently to direct its course. It is this, then, his wholly new *kind* of command of physical nature, that constitutes the gain of man since Franklin's time. Therefore, neither in the realm of statecraft, of philosophy, of literature, nor yet of art is it that the spirit of Franklin would wander to-day, awed, astonished, and confused, but in that of physical science, a province which he so thoroughly loved and knew.

The figurative suggestion of the returned Franklin, wide-eyed and curious, intently observing the strange uses to which the materials and forces of the earth have since been put, serves but to illustrate the fact that in less than a century man has wrung for himself more helps from nature than he had previously gained in all the long history of his race. We are indeed living in the heyday of physical discovery.

But a single further thought upon the subject need detain us. Now that the mind of man has been so suddenly unleashed in the field of objective research, a field for centuries almost wholly forbidden it, are or are not the astonishing discoveries which seemingly without number are nowadays being showered from an apparently inexhaustible horn of plenty, in reality but a part—how great we do not know—of a really exhaustible capital treasure? I am not suggesting that the fund of uncomprehended or unknown phenomena can ever be drained—none

would dare assert that—but I am inquiring as to whether the time may not come when the easily discoverable, the readily utilizable phenomena shall grow less, and men have to be content with lesser finds, of gradually diminishing worth, for which they must ever go further afield.

Is it not conceivable that the at-present precipitate rate of progress results from the sudden release of an accumulated store of aptitude for dealing with physical phenomena—an aptitude that has been gathering for many centuries without an opportunity for its application—which is now hastily catching up with easily discoverable things and is, therefore, super-normal? And is it not supposable that with the expiration of a brief span, as history counts time, man shall have exhausted much of the unknown that lies nearest to hand and be reduced to the consideration of progressively less important, more minute, and more remote phenomena? Therefore, is it not reasonable to assume that at some distant, perhaps far distant, time the world will revently look upon the present era, as in art and philosophy we moderns look upon that of Greece, and refer to it as the Golden Age of Science?

However interesting this train of thought may be, suggested as it was by contemplation of the wonders that have flown to earth since first this venerable hall was built, I am sharply conscious of the fact that my lecture to-night is to be not upon the general topic, Science, but upon only that department of physics which deals with the mechanics of one of the branches of printing.

Of all the mechanical creations of man perhaps that which has worked him the greatest good is the art of printing. Upon it depend all other arts for their propagation and preservation. And not only do the arts, using the word in its broadest sense, pass current through the medium of the printed page, and owe to it their permeability and perpetuation, but so also does every thought of the mind which is held worthy of multiplied expression. Indeed, of all the whirring, hurrying, helpful enginery of the day but a single device, the printing press, is engaged in preserving against the needs of those to come the gathered knowledge of mankind. In the domains of his thought, his sight, his action, man has set up the press to speak for him; and out of it there ceaselessly pours the perfect record of them all.

It is of the journal, the daily newspaper, in which appears the likeness of the vast structure of each day's human experience, that it is my duty to speak to-night. Not, I regret to say, of the newspaper itself, of its phenomenal powers, and the intricate tendencies for good or evil which still seem inextricably linked in its pages, but of the insensate automata which, under the hands of its sponsors, bring the newspaper into physical being and launch it in daily myriads upon the world.

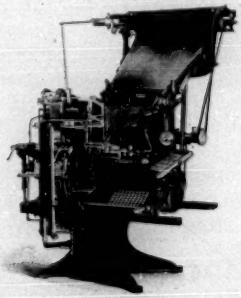
Printing began with the making of handcut blocks, which were used to stamp their similitude upon other surfaces. Later, blocks called type bearing each a single character were made, and these when combined one with another produced words which, when gathered into sentences and paragraphs, became the page. The great impetus given the typographic art by the introduction of "movable types" was due to the ease and economy with which text could be prepared for the press, and after printing the type page be resolved again into its component characters, which thereupon were fit and ready for further use.

The work of cutting characters being slow and costly, recourse was soon had to casting them, of an alloy of lead, antimony, and tin from moulds, now called matrices. These were made of plaster from types or dies which had been cut by hand; and later of copper from harder dies which, upon being driven into it, left their impress. Until recently the driven matrix was exclusively used; but nowadays the manufacturers of type cut their matrices by means of a power-driven engraving device, the controlling lever of which is guided by hand along the edges of a large template, or raised representation of the particular character to be cut. Thus by means of the Benton-Waldo machine unskilled men, working with great rapidity, can produce the most intricate matrices at little cost. When matrices are required to be made in large quantities, as for use with the type-making and composing machines of the modern printing office, they are still driven, the dies, or "punches" employed, being engraved by the Benton-Waldo method. The matrices of extremely large type-sizes which are now upon the market, are usually neither punched nor cut, but are electrolytically-deposited copper impressions of existing types.

For many centuries the setting of type was a manual operation. It required a high degree of special knowledge and great

dexterity. With the setting, or "composition," of a page the type-setter's work did not end; when the page was no longer required he had also to "distribute" the type it contained. The putting of matter into type involved the necessity of taking it out again. Such a dual process was entirely comfortable to the printer until, and long after, the newspaper came into being. But when the value of celerity in the printing of news began to be understood the slowness of "the man at the case," became irksome, and a mechanical substitute for his eyes and hands was sought. This brought into being the crude type-setting devices of the third quarter of the last century. These, like the man,

FIG. 2..



The Linotype Machine—used for setting and casting the lines of type of which the modern newspaper page consists.

had to distribute as well as compose, and each function was given a mechanism of its own.

Meanwhile the growth of the newspaper in telegraphic matter and general bulk was pushing it on to demand still more rapid and ample appliances; and these so far as the composing room was concerned were at last supplied by Mergenthaler's matrix-setting-and-type-line-casting machine, called the Linotype (line of type). This device worked upon a new principle. Instead of seeking to set the types, and after their use to distribute them among their respective receptacles in order that they might again be automatically composed, it composed the matrices of type, and from these cast, as a single piece, a line of characters.

Mergenthaler's matrix was of brass, flat and rectangular, having a V-shaped notch cut deep into one, its upper, end, the edges of which were lined with small hook-like protrusions. These protrusions were arranged to act like the convolutions of a flat lock-key: because of them a matrix could drop from the V-shaped ward bar from which it hung during its automatic distribution after use only into its own reservoir, or channel, of the matrix magazine. The magazine and matrix distributing apparatus occupied the upper portion of Mergenthaler's machine and to it, after each had been once used, the matrices were automatically returned. The convolutions of all the matrices of each character were alike; but those of no two characters were the same.

From the channel-like reservoirs of the magazine the matrices were released in the order in which they were wanted, by the manipulation of finger-keyes; and upon coming from the magazine were assembled side by side with their intaglio characters in line. A wedge-like piece was inserted between each pair of words to wedge the line out to its full width should it be short, a function spoken of in typography as "justifying." The assembled matrices and wedges were thereupon automatically transported to a casting mechanism, where their character-casting surfaces were pressed against the mouth of a slot or mould, which was as long as the width of the column of the newspaper for which the line was to be cast, and of breadth suitable to the size of the type-face required. In depth the mould was type-high. Against the opposite opening of the mould was placed the nozzle of a pump, by which, at the proper moment, the mould was filled with type-metal and a bar cast having upon one edge the line of type. The mould was then automatically moved clear of matrices and pump, and the bottom of the cast smoothed by a knife. Then the cast, or "slug," having been ejected between knives to give it accurate thickness, was ready for use. Meanwhile the matrices were lifted to a position abreast the top of the line of reservoirs from which they had come; whence, suspended each by its particular convolutions from the wards of the V-shaped bar along which they slid, they were pushed over the mouths of the channels, and each character dropped where its retaining ward ended. The wedges or "space-bands" were left behind when the matrices were "elevated," and returned to their starting point.

Thus, by the mere acts of playing his keys and touching a

handle upon the assemblage of a line of matrices, an operator was enabled to make composed and justified lines of new type at a then unheard-of rate of speed. Moreover, the "type" he had set needed not to be distributed for re-use; the line had only to be tossed into the melting pot of the machine to be born again as new matter. Where other mechanical compositors had required three men for their use, one to set, another to justify, and a third to distribute their work, the Linotype needed but one, and could be worked with such ease and rapidity that it went instantly into general use.

Upon the heels of the success of the Linotype came another device, the Monotype, which, although not of so great value to the newspaper publisher, was gladly received by the printer of books and commercial work. The Monotype consisted of two independent mechanisms, the one a keyboard by means of which the operator was enabled rapidly to perforate a paper ribbon with holes which represent characters, and the other a type-casting mechanism to which the perforated tape thereafter was fed. The latter device comprised a movable frame in which the matrices of 225 characters were fastened, a type mould, automatically adjustable to suit the various widths of the characters of the alphabet, with which a metal pump was connected, and pneumatic mechanisms for controlling the position of the matrix-carrying frame, and the width of the type mould. To these was added a general mechanical organization which enabled the perforations of the ribbon, by means of air, as it was drawn through the machine to properly place the matrix frame and set the mould for each character needed, while the pump and co-operating parts acted to cast the character and place it in its correct position in a tray, or "galley," at the rate of 150 characters a minute.

Of all the type-setting machines, properly so called, which preceded the Linotype but one has survived—the Thorn-Simplex-Unitype machine. In this foundry type are contained in slot-like reservoirs cut in the periphery of a drum. About the bottom of this drum, which stands on end, rotates a flat disk, and out upon this the type are thrust when released by the keys, and by it are carried in the order of their release into a mechanism which picks them up, puts them on their feet, and assemblies them into a line. They are then taken in lengths of a column's width and, after being quickly justified by hand, are ready for use. A clever

device of this machine is the means by which it is enabled to take a whole galley of type, and properly distribute it among its reservoirs. This is accomplished by providing the type-body of each character with an arrangement of "nicks" which is possessed by the body of no other character. At the head of each slot-like reservoir is a particular arrangement of wards, like those of a lock. The wards of a reservoir will permit to enter it only the character whose body has nicks to suit. The lines of type which are to be distributed are automatically taken from their galley and inserted, a line at a time, into slots in another drum. This surmounts the reservoir drum already referred to, their axes and the alignment of their slots being common to both. The upper drum rotates with a step-by-step motion, and at every stoppage its slots coincide with those of the lower drum. Thus it will be seen that as soon as a character carried by the distributing drum reaches a position above its own reservoir, it will drop into it, but that no other character can do so. The Unitype machine, being less costly to purchase and more economical to run than Linotype or Monotype, is in very wide use among the smaller newspapers and printers of books and magazines.

In these few words I have sought hastily to carry the art of type-setting through its various stages of progress, and to describe the mechanisms by which it is practised to-day. Where an expert compositor formerly could set by hand but 750 "ems"[1] an hour, he has been known with a modern machine to set from 3,000 to 12,000 ems. Such large daily papers as the *New York Herald* and the *New York World* use from 60 to 70 Linotype machines each (the *New York Sun* uses Monotypes). Without such a machine it would be physically impossible to issue newspapers of this class, in so far as their bulk and the celerity of their publication is concerned. So much has the mechanician done for the setting of type.

Coincident with the introduction of movable types one first hears of the printing press. This instrument is said to have come of humble origin; to have been in fact but a development of the cheese or cider press common in mediæval times. It first con-

[1] The "em" represents the square of the size of the type used, and is derived from the letter M, which is as broad as it is long. It is the unit by which composition is measured: if a column is 12 "ems" wide, and 50 lines long, it is said to contain 600 ems.

sisted of two plates between which the inked type, covered with a sheet of paper, was introduced and by which it was pressed. The necessary squeeze was applied by means of a hand-turned screw, set in a surrounding frame, which bore upon the upper plate. Next came an improved form of screw-operating mechanism. Next, the lower plate was made to slide out to receive the type "form," as it is now called. And later a frame, covered with fabric to which the sheet was secured, was made to hinge down upon the type before the table upon which the type rested should be slid beneath the upper plate. This table is now called the "bed," and the sheet-pressing plate the "platen," of a press. In those days the ink was applied by means of hair-stuffed leathern balls. These, dabbed with ink, were patted together until their ink-film was suitably evened out or "distributed" and were then carefully pressed upon the type. With such a press about 200 sheets of small size, printed upon but one side, could be done in an hour. At its next step the press became of iron, and was adapted to print larger sheets. Then a genius conceived the idea of replacing the flat, sheet-pressing platen, by a rotating cylinder upon the surface of which the sheet was held by bands of tape. Beneath this cylinder the type form was pushed, and thus the cylinder printing press was born. Next were applied ink-charged rollers made of glue and molasses which, as the type was pushed toward the cylinder, served to ink it. Better means for propelling the type-bearing table or bed were soon forthcoming, as well as for causing the cylinder to turn more accurately, and with greater certainty to take on and give off the sheet. Power other than that of the hand was applied, and it became possible to print upon one side of a sheet at the rate of a thousand "impressions" an hour.

Meanwhile the flat or "platen press" as it is called, shared in the general advancement of the engineering arts. It became a self-acting machine; of itself took its sheet from the hand of the printer and drew it into position to be printed, and impressed it upon the type, which it had previously inked. Thereafter it gently laid the sheet upon a table, a thousand such sheets to the hour. Having attained to this degree of development the growth of the platen species of printing press ceased forthwith and, except in connection with the smaller sizes of commercial work and a few obscure branches of the printing industry, it is no longer a factor.

As an increasing speed of production is ever of the essence of industrial progress, the mechanical species which survive are necessarily those which lend themselves to celerity. Of such a species was the cylinder printing press. With the betterment of materials and of motion-producing mechanisms, the attainable speed of its reciprocating type-bed and its sheet-bearing cylinder soon enabled it to outrun the older and more cumbrous flat press; and thus it came to assume the burdens of newsprinting. The single cylinder press, printing upon one side of a sheet, was soon followed by a machine having two sheet-bearing cylinders, and a double-length bed upon which forms a type for printing the back as well as the front of a sheet were borne. By an ingenious arrangement of endless tapes the sheet, having been printed upon one side by one cylinder, was transferred to another cylinder and by it printed upon its other side. Such a press was said to "perfect" the sheet, and so came to assume the name of "sheet-perfecter." Other double-cylindered presses, also, were used, which were adapted to print upon but one side of the sheet. Such a machine carried upon its bed a single form of type to which each cylinder in turn presented a sheet; the one cylinder upon the forward stroke and the other upon the backward stroke of the bed.

Fifteen hundred papers an hour were not, however, long going to satisfy a public rapidly growing in its appetite for news; so another step was taken, this time by Applegath, for the London *Times*. By setting a cylinder upon its end, its axis in vertical position, and fastening into it the metal column rules of the paper, Applegath was enabled to lay the columns of type between these rules and so clamp them to the column-wide facets of his cylinder as to cause the type to withstand the centrifugal force of a quite respectable velocity of rotation. About this type-bearing cylinder were set parallel sheet-bearing cylinders, to and from which hand-fed sheets were conveyed by rather complicated systems of tapes. In this way the *Times* for many years was printed. Hoe in this country conceived a better arrangement. By the use of wedge-shaped column rules he was enabled so firmly to hold the columns of type in place as to enable him to set his cylinders in a horizontal position. Hoe presses having four, six, eight, and even ten

sheet-bearing cylinders, which ran in contact with a central type-bearing cylinder, came into general use. Having a "speed" of two thousand turns of the type-cylinder an hour such a press, with ten sheet-bearing cylinders, was capable of turning off twenty thousand sheets. These, being printed upon but one side, had of course to be put through the press again, the type-pages, meanwhile having been changed. Hoe's next step was to place in a machine two type-bearing cylinders, so that both sides of a news sheet might be printed at a single operation.

But even ten or twenty thousand newspapers an hour failed to satisfy the growing public need. The presses of the day were already working at top speed. Type-setting was so slow and costly that forms could not be set for more than one press; so an establishment was limited to the use of a single machine. Something had to be done. For some time there had been known and used the process of stereotyping, which was that of producing replicas of a form of type, in type-metal. To practise stereotyping a type-form was stamped into a moist clay surface, where it left its impression. The clay was baked, then put into a receptacle and type-metal poured upon it. When the cast had cooled the clay was broken from its surface, its edges were trimmed with a tool, and its back smoothed with a plane. Then it was ready for press. By repeating the processes of moulding and casting it was possible to continue indefinitely to reproduce a type-form. But the resulting stereotypes were flat, and for the rotary newspress it was desirable if higher speeds were to be obtained that printing forms should conform to the curve of its cylinder.

In this hour of the newspaper's need someone, it is not certain who, conceived the idea of substituting for the clay of stereotyping a sheet of papier maché. This was composed of several thicknesses of soft paper moistened with paste and covered with a skin of tissue. It was laid upon the type and beaten in with a brush. Type and paper were then covered with a dry blanket of felt and thrust into an oven-like press till the matrix was dry. Such a matrix, being flexible, could be conformed to the interior of a curved casting receptable and, being tough, could be stripped from a cast and used again. This method of stereotyping originated abroad, and was brought to this country by Traske who first put it to work upon the *New York Herald* and the *New York Sun*. Thus, for the first time, the news-

paper was enabled to make innumerable curved replicas of its type-forms, and indefinitely to multiply the number of its printing machines. It should be noted in passing that with the advent of the curved stereotyped printing plate the larger newspapers ceased for good to use type for the purpose of printing.

The substitution of curved stereotyped printing plates for type gave to the newspaper two new advantages. Many presses could be used; and these could be run at higher speeds than were possible where printing surfaces were made up of individual types which were held to a cylinder merely by wedges. Bullock, of Pittsburg, was the first to offer a press which properly utilized these advantages. His machine was not only adapted to use curved stereotypes at a high rate of speed, but to it he had attached a device for severing sheets from a roll of paper, thereby feeding his press automatically; and another device for rapidly laying the sheets when printed neatly in pile. His press, thus being automatically fed and delivered and adapted to print from curved plates upon both sides of a sheet, quickly came into general use. Hand-fed machines for folding newspapers were already in vogue, so it was but a short step to the attachment of such a folding machine to the press itself.

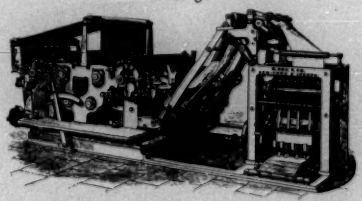
But progress was still insistently at work. The annoyance of carrying separate sheets through a rapidly-running machine must be dispensed with. This was soon accomplished, and the paper was drawn from the roll into the press, and printed while still in "web" form upon both its sides. Then it was cut into sheets and folded. Thus there resulted the web-printing, as distinct from the sheet-printing, machine.

Further improvements now followed one another in rapid succession. The slow, intricate, and uncertain chopping-blade folder at first employed was replaced by a rotary device which, working with simplicity and accuracy at a much higher velocity, greatly increased the productivity of the press. The products of two presses were next run into a single folder which thereupon delivered a folded newspaper of double the usual number of pages. These two innovations were first put into practice by Andrew Campbell,[2] of New York City. The columns of the

[2] Machines having Campbell's rotary folder were used by the *Jersey City Evening Journal* and the *Cleveland Leader*. In the last mentioned machine the webs of two presses were run into one folding mechanism and there assembled and folded as a single product. Campbell failed to patent his inventions and thus lost them.

print, which theretofore had run across the web, were next turned about and run with it. Thus the centre margin of the newspaper along which it is folded became the centre-line of the web. As a curved stereotyped plate occupies but half the circumference of the cylinder of a newspaper press, two were required to complete the circle. As each printing cylinder bore four such plates and there were two such cylinders it was possible at each revolution to print an eight-paged paper. By cutting the sheet from the web between the forward and after pages and laying the first half upon the last, an easily handled eight-paged paper became possible. Such a paper had neither to be cut by hand nor turned inside out in order that its pages

FIG. 3.



Hoe Stereotype Printing Press of the early '80's—capable of printing and folding 4-or 6-paged papers at the rate of 24,000 an hour; or 8-or 12-paged papers at 12,000. Illustrates the use of angled bars for transferring from one side of the press to the other a portion of the paper-web; the V-shaped device for giving the paper its longitudinal fold; and the rotary mechanism by which the sheet is severed from the web, is folded, and then delivered. These principles are found in the newspresses of the present day.

might be read by the holder in sequence. This operation was called "collecting." There were occasions when the forward and following plates were alike; then the sheet-collecting mechanism was disconnected, and the papers delivered had but half the number of pages. In this way four-paged papers were run. Such a press was able to deliver twice as many papers having four pages as eight. The products of two printing machines, when run together into a collecting mechanism and folder, resulted in sixteen-paged newspapers. But with the collector thrown out of operation, twice as many eight-paged papers could be obtained. With three presses the respective products were twenty-four paged, if collected; twelve, if uncollected: with four presses, thirty-two, and sixteen. Meanwhile it had become possible to combine the full-width web of one press with a half-

width web, one page in width, brought from another. Thus, such a product if not collected produced a six-paged paper or, if collected, a paper of twelve pages. In this manner it became possible to print at will, upon a machine having four printing-couples, newspapers with four, six, eight, ten, twelve, fourteen, sixteen, twenty, twenty-four, twenty-eight, or thirty-two pages.

Meanwhile the practice of cutting sheets from the web before they were folded had given way to a more certain and rapid method. A new form of folding device was introduced, which comprised a V-shaped frame of iron down over which the printed web was drawn by two milled rolls running towards each other at its lowermost point. The web coming full-width over this device, was so shaped or formed in the course of its travel downwardly over its face and about its sides, as to enter the rolls beneath its "nose" as a folded web. Thus it became possible to give the sheet while "on the run" its first, its longitudinal fold, and to do this before it should be severed from the web. Beneath this device, or "former", as it is called, was placed a pair of cylinders which co-operated to give the already once-folded sheet its second, or transverse, fold and thereafter to sever it from the web. The act of cutting was accomplished by pressing a sharp, serrated blade carried by one cylinder into a slotted rubber bar carried by the other. The principle of cutting demanded that the sheet be held taut over the cutting-slot while the saw-toothed blade burst through it. This was accomplished by placing at each side of the knife spring-supported wooden bars which, pressing the paper against the rubber at each side of the blade, held it taut at the moment of cutting. One of the cutting cylinders bore pins which, by impaling the leading end of the once-folder web, enabled it to carry the paper part way around until the instant arrived at which it was cut from the web and became a "sheet." Then, as the pins released its forward end, it was struck across its middle by a suddenly-protruded folding blade, carried within the cylinder, and driven downwardly between a pair of co-operating rollers by which a second or transverse fold was given it. The twice-folded paper was then shot into a rotating frame of S-shaped arms, called a "fly," which laid it upon a slowly-moving apron of endless bands from which, when papers enough had gathered, it was removed by hand. Working in conjunction with the fly was a device

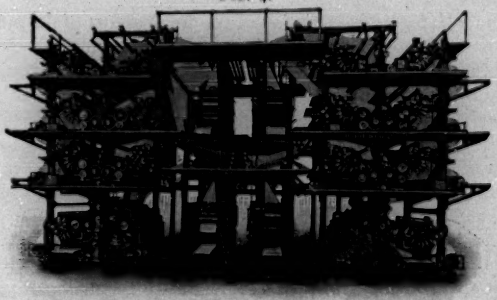
which slightly threw out of position every fiftieth paper; so the necessity of hand-counting, except for smaller quantities, was dispensed with. It should be added that the cylinder which was opposed to the sheet-bearing cylinder described, was so fitted with pins that it could also perform the function of collecting, and thus papers of double the number of pages be produced. This cylinder bore the serrated knife, while the sheet-bearing cylinder carried the rubber-slot and folding blade described. When it was wished to collect the forward with the after product of the press, the pin mechanism carried by the knife-cylinder picked from the other cylinder the first-coming sheet by its forward edge and, after making a revolution which gave the second sheet time to arrive, replaced the first sheet upon the first cylinder directly upon the second sheet. The collected product was thereafter folded, delivered, and counted as a single newspaper.

But two other features of the press under description—which is the newspress of the present day—remain to be mentioned. Some years ago it became the practice to construct presses four pages in width. This necessitated the employment of double-width webs. Its advantage lay in the fact that by means of two rounded bars, set at an angle of 45 degrees with respect to the direction of travel of the paper, it was possible after the web was printed and split to transfer part of it across the press and impose it upon its other part. Thus, the portion of the web printed at one side of a press could be transferred laterally, and associated with the portion printed at the other side of the machine, and both pass into a folder to emerge as a single product of a greater number of pages.

The printing machines of the present day are composed of many printing-couples, the products of which are gathered folded and delivered by one or more folding machines. A printing-couple is composed of the plate-bearing printing cylinder and its co-operating blanket-covered pressure-cylinder. It is by the latter that the web is borne to receive the impress of the type. A four-couple press of four pages in width has usually two folding machines, or "folders" as they are called. The normal speed of the modern folder being 24,000 newspapers an hour such a press may be run at the hourly rate of 48,000, four, six or eight-paged papers. Or, if its two webs are split and the parts from one side are transferred over and combined with those of

the other, and all are run into one folder then, as but one folder is being used, the number of pages of each newspaper produced may be doubled, but a production of but half the number of newspapers will be possible. Thus 10-, 12-, 14- or 16-paged papers may be produced by a four-couple press, which is technically known as a Quadruple, or "Quad" machine, at the rate of 24,000 copies. A machine having six printing-couples, known as Sextuple, or "Sex," by using two folders is capable of all the combinations of a "Quad," but by using an additional web is able to make 10- and 12-paged papers at the rate of 48,000, and 18-, 20-, and

FIG. 4.



Hoe Double Octuple Printing Press—composed of 8 double-width printing mechanisms, and 8 folding machines. Its maximum indicated capacity is 192,000 four-paged, or 96,000 eight-paged papers an hour. When completely plated it requires 128 stereotyped printing plates.

24-paged papers at the rate of 24,000, an hour. An Octuple, having eight printing-couples and using four webs is capable of turning out products of 14 and 16 pages at the greater rate, and of 26, 28, 30 and 32 pages at the lesser rate, of speed. Octuple machines usually have four folding mechanisms and thus are able to attain a rate of output upon products having eight pages or less of 96,000 copies. There are, also, machines in use having twelve printing couples; while still others, known as Double Octuples, have sixteen. With collecting mechanisms at work in each case a product of double the number of pages may be obtained; but at half the full rate of production. Competition has recently driven the manufacturers of newspresses

to rate their machines higher in speed than that mentioned, but as no essential change has been made in the mechanisms employed little real gain in the actual hourly average of product has resulted. It should be understood that the rates of output cited are merely "indicated." In practice the speed of two hundred turns of a press-cylinder per hour which, if continued for the hour, should produce with one folder 24,000 copies, actually results in but from 16,000 to 18,000, more or less. A press must be stopped when each of its web-rolls expires and resupplied with paper, which greatly reduces the number of minutes run in the hour, and paper-breakage, which is a frequent source of trouble and delay, still further reduces its output.

In the foregoing description of the development of the modern newspress, I have not thought it necessary to refer to the transitory forms of machines which have occasionally appeared, but have deemed it sufficient for the purpose of this lecture to trace the main stream of progress along which the machine of to-day has come.

From the foregoing it will appear that the newspaper now depends upon the co-operation of three important mechanical departments: the composing room, the stereotyping foundry, and the press-room. Having shown how the newspaper is "set," and how it is printed, I shall now take up the indispensable link which connects the two. This brings me to the main subject of my lecture, Stereotypy, Old and New. In order to illustrate the great importance of the art of Stereotypy I shall set before you the images of two newspaper offices, the one with out, the other having, the advantages which stereotypy confers. In the first the type, clamped in curved frames called "turtles," may be used upon but one press. The turtles having been secured in place and the machine started, in the course of an hour's time 10,000 copies, or at most 20,000, are produced and distributed. How little such a puny output could satisfy the needs of the present day will appear when it is known that the circulation of many evening papers is now above three hundred thousand copies, and that there are some that closely approach to half a million. My second image need be nothing more than that suggested by the statement that in a modern metropolitan newspaper office will often be found combined in one form or another from forty to sixty complete perfecting printing mechanisms; and that within

twenty minutes after the arrival at its stereotyping foundry of the last page of type all of its presses fully supplied with printing plates will be turning off newspapers at the speeds I have mentioned. The importance of the art of Stereotypy is plain when it is realized that by means of it a plant containing sixty press-units is now possible, and that such a plant is capable of producing the equivalent of from seven to ten hundred thousand eight-paged newspapers an hour. Thus it will be seen how vastly it has multiplied the productiveness and therefore the usefulness of one of man's greatest mechanical discoveries—type.

FIG. 5.

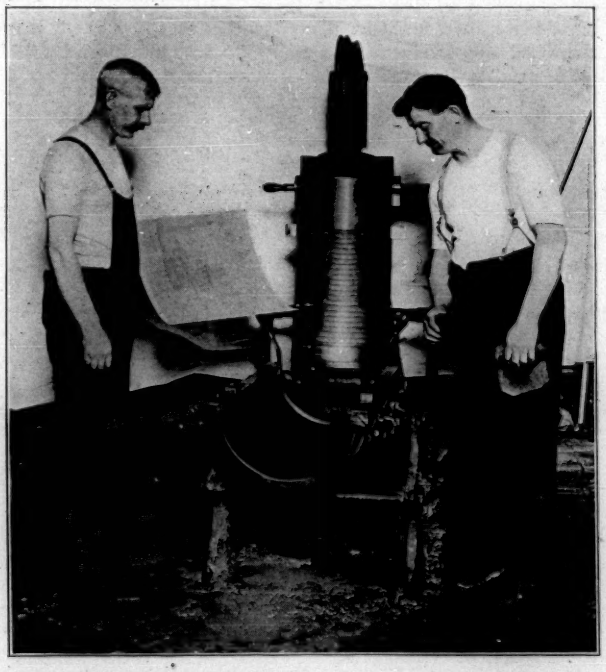
A Finished Stereotyped Printing Plate.

In the year 1890 I first became interested in the art of Stereotypy, which was then being practised exclusively by manual means. But a few devices, power-driven and hand-controlled, had been provided to facilitate its work. One was used to remove the riser or sprue of the freshly cast plate, while another, when the plate had been dropped into it by hand, served to smooth out the plate's inner, or seating, surface. In but one other function was the work of the hand assisted by power. The moist papier-maché sheet, or "flong" as it is called, after it had been laid upon the type-page and covered with a felt pad, was moulded to the face of the latter by an iron roller beneath which it was drawn upon a bed propelled by power. Excepting these, all of the operations of stereotyping required the direct employment of the thought, the eyes, and the hands of workmen.

The process of stereotyping then in vogue may briefly be

described as follows: To prepare the flong two blotter-like sheets of paper were pasted together, and upon one side of these four sheets of close-fibred rice-straw tissue were pasted. The paste used, its composition then a trade secret, was of flour, a

FIG. 6.

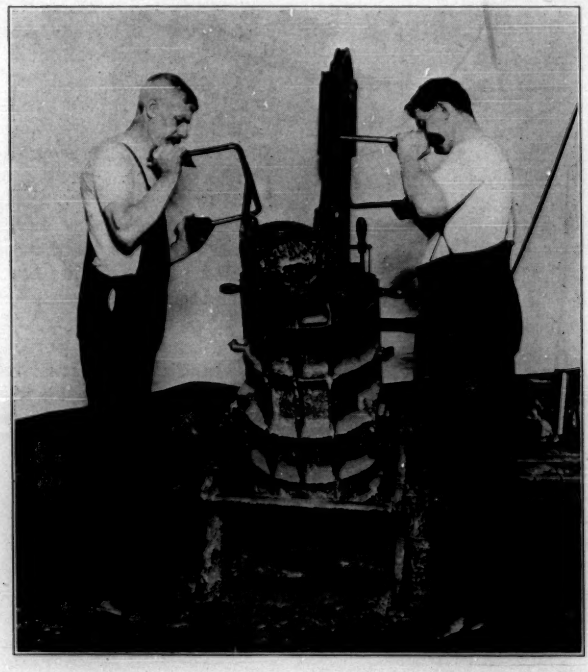


Hand Plate Making—setting the matrix.

clay, and a germicide, the latter to prevent fermentation. Flongs enough were made for the next day's requirements, and these were allowed to season in a moist place. As each type-page reached the foundry a flong was laid upon it, tissue-side down,

and upon the flong a closely-woven stout felt blanket. Page flong and blanket were then run beneath an iron roller, the operation of moulding thus being performed. Before the advent of the moulding-press, the flong was beaten into the face of the type-

FIG. 7.



Filling the Casting Box.

page by long-handled brushes; a slow process, which the roller superceded. From the moulding press the type-page with its moulded flong (now become a matrix) still clinging to its face, was carried to a steam-heated iron table where, the moulding

blanket having been exchanged for several layers of dry soft blanketing, an unheated iron plate or "platen" was screwed down upon it. Heat, thus applied to the type, drove all moisture from the matrix into the blankets and usually in from four to six minutes the matrix, or "mat" as it is usually called, became dry and was ready to be cast from. In the eighteen years that have since elapsed this process of moulding and drying has undergone but a slight improvement. Better paper and paste have increased the durability of the matrix, and an improvement in technic has made it more sensitive to the delicate "effects" of modern illustrations; but, if a slight reduction of the time consumed in its making be excepted, the process of matrix-making has scored no substantial gain. Of progress in the making of plates, however, a different story is to be told.

When stereotyping was first adapted to newspaper printing, certain implements were necessary in order that suitable printing plates might be made. The employment of the rotary press required that the plates be curved. It was also requisite that they be of uniform thickness, and that their curved ends be bevelled so that they might be held by clamps to the cylinders of the press. These conditions necessitated the use of a curved casting-mould, or "box" as it is called. In this the paper matrix was bent and clamped. The mould was then closed, a hinged semi-cylindrical core acting as cover, and into it a ladleful of molten stereotype metal was poured, by two men who had fetched it from a nearby cauldron. After the appropriate time for solidification had passed the mould was opened and the casting, with its clinging paper matrix, removed. Then the delicate operation of stripping the matrix from the face of the cast was cautiously performed, and the matrix was returned to the mould and repositioned for another cast. Meanwhile the first cast was placed upon the cylinder of a "cutting-off" device where, after having been nicely positioned and securely clamped, it was turned beneath a power-driven rotary saw and its riser, or rough upper end, removed. The saw of this apparatus was so shaped that it left the curved edge of the cast bevelled. The cast was then turned and its other end passed beneath the same saw, in order to insure to it likewise a satisfactory clamping surface. The cast was then inverted and dropped face-down into the hollow of a "shaving-out" device, in which a rotating straight-

edged knife served to smooth or plane its inner surface, and to give it an accurate thickness. In order to reduce the surface thus needing to be planed it was customary to construct the core about which the cast was to be made with narrow circumferential

FIG. 8.

Opening the Casting Box.

grooves, set an inch or so apart. In the casting operation these grooves were reproduced upon the inner surface of the cast as ribs, or finishing strips, and furnished a surface which, when planed, was ample to support the cast plate under the pressure

of printing. After it had been shaved the cast was next set, face up, upon a fixed cylinder, or "horse," where two men, with hand-plane and chisel, removed from its edges all superfluous metal, which might otherwise take ink and print. This was called

FIG. 9.

Removing the Cast Plate.

"finishing." From the finishing horse the cast plate was next carried to a trough and cooled, and thence to the press-room where it was dried and clamped to the cylinder of a press. All of these operations, save only the propulsion of the cutting-off

saw and shaving knife, were performed by hand. And for each plate made every function, from the precise positioning of the matrix to the drying of the finished plate, had to be repeated.

The casting mould was a heavy and clumsy piece of apparatus, which consisted of back and core, a bottom "ring," beneath which the lower matrix-edge had to be clamped, two side-bars which had then to be laid upon the straight sides of the matrix to hold it in position, and clamps for finally locking the halves of the mould together before it should be stood on end to be filled. Two men were required to insert and position the matrix, and put the mould together, and likewise to take it apart after its contents had cooled, and remove the cast and matrix. Another man was required to cut off the riser, a fourth to shave the plate, a fifth and a sixth to "finish" it, and still another man to dip it. The rapidity with which such a crew could work, with a single casting mould, was at the rate of a plate in every minute and a half. Thus in order to produce ten plates from a matrix, or enough to supply five quadruple presses with the plates required to enable them to print a single page, from fifteen to twenty minutes were consumed. If, in an office having five such presses, an eight-paged paper was to be run, eighty plates had to be made, the casting and finishing of which consumed nearly two hours, if but one casting box were used, or half the time if two, as was the custom, were employed.

As the circulations and bulk of newspapers increased, presses and pages were added, until at last the one hundred-odd paged Sunday issue, produced in a press-room having no less than sixty unit printing mechanisms, each requiring perhaps sixteen printing plates, ceased to be a rarity. As its pages and presses grew in number, so also did the stereotyping plant of a newspaper in the number of its men and pieces of apparatus. And at last the pressure of plate-making became intolerable in the offices of the large metropolitan journals. Nevertheless, up to the close of the last decade of the last century, the process of stereotyping was carried on in the primitive manner described, and entailed the performance of hard manual labor under injurious conditions of temperature and haste.

The accompanying illustrations of the hand-worked process of plate-making exhibit the principal operations to which I have referred, and are representative of the most advanced state of the

art when, in 1900, the Autoplate machine was first set to work in the office of the *New York Herald*. Perhaps the most concise summary anywhere to be found of the nature of the change effected by the introduction of machine stereotypy, is in the fol-

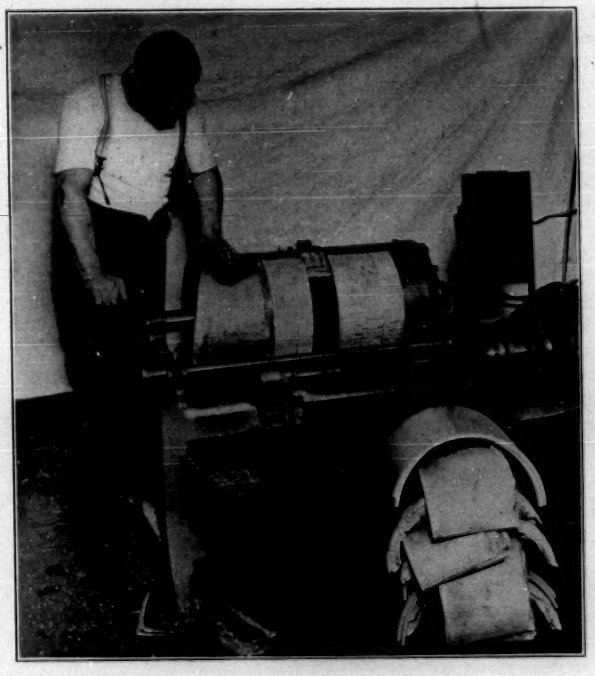
FIG. 10.

Stripping the Matrix from the Cast Plate.

lowing extract from the *New York Herald* itself: "The third department of newspaper mechanics—stereotyping—has remained almost at its starting point, one of the few arts still in the realm of hand labor. It is twenty years since the last

improvement was made, and now, in the last year of the century, the art is raised to the mechanical level of its sister arts by Mr. Wood's invention, which does automatically, with few men's hands to aid it, what formerly required many hands and four-

FIG. 11.



Cutting the Riser, or "Tail," from the Cast Plate.

fold the expenditure of time. Thus, in the closing year of the nineteenth century the last act of the mechanizing of the printing trade has been accomplished. First came the rotary press in 1860, then the linotype in 1888, and now the autoplate in 1900."

Speaking generally, the Autoplate consists of a casting mechanism and a series of finishing mechanisms which automatically co-operate in one machine to make the casts and finish them. When used to make plates of the conventional half-inch thickness, its speed is four finished plates a minute; but where the thickness is but a quarter of an inch, from seven to eight plates a minute are easily to be obtained. In the casting mechanism, which occupies one end of the machine, the matrix is placed. The operator by the movement of a lever starts the machine to casting, and this proceeds automatically until the desired number of plates is made and forwarded to the finishing mechanisms. Then, by a reversed motion of the lever, the casting mechanism is brought to rest, when the matrix is exchanged for that of another page. So quickly may this exchange be made that there is lost but the time required to make one cast. Meanwhile, the finishing mechanisms, which run continuously, finish and eject the remaining plates of the previous casting operation. While the machine is at work the matrix is cared for automatically: having been once inserted it requires no further attention until its full quota of plates is cast. Its controlling mechanism is so constructed that the matrix is manipulated with the utmost gentleness and precision; and as many as a hundred casts may be made from a single matrix.

From the casting mechanism the plates go automatically through various finishing operations, and when delivered are ready for the press. These operations consist of sawing off the sprue, which is cast by the Autoplate machine at one of the straight edges of the plate; of sawing a narrow strip from the other straight edge of the plate; of shaving the plate's inner surface to bring the plate to accurate thickness; of accurately dressing the bevelled clamping edges and, upon the latest machines, of finally bathing its inner surface to cool the plate, without wetting its printing face. Thus, the entire work of casting, finishing, and cooling the plate is now automatically performed at the rate of eight plates a minute, by a machine which may be run by three men, whose only work consists of supplying its furnace with metal, its casting mechanism with matrices, and of removing the finished plates when ejected by the machine.

By the hand method of plate-making the same amount of

work could not have been done by less than 35 men; and even with so large a force the saving of time made possible by the Autoplate could not have been obtained, for eight matrices instead of but one would have been required.

FIG. 12.

Shaving, or Planing, the Inner Surface of the Plate.

The time saved a newspaper by means of the Autoplate machine may be divided into two parts; that which occurs in the closing of its type-pages which, because of the speed of the Autoplate, may now be held open longer than previously was

possible; and that which occurs in starting the presses after the last page is closed. Not only may the first press of a battery be started earlier, but each succeeding press will receive its full complement of plates many minutes ahead of its former starting

FIG. 13.

Removing Surplus Metal from the Surface of the Plate, by Chisel and Plane.

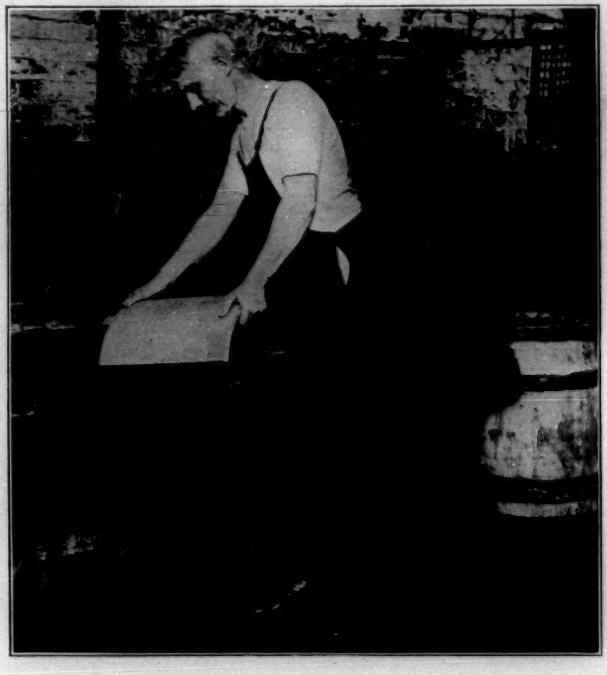
time. Thus, a large portion of the time that each press formerly spent in waiting for plates is now utilized in producing newspapers, and a great increase of product during the first portion of a run obtained. It is apparent, therefore, that the Auto-

plate increases the capacity of the composing-room by giving it more time in which to work, and enlarges that of the press-room by making possible the early starting of presses which otherwise would stand idle awaiting their plates; and thus fewer presses need be used. Furthermore, the Autoplate shortens the time between the receipt of news and its publication, and reduces the cost of stereotyping.

The following is a brief technical description of the machine itself. The core, about the lower half of which the plate is cast, is a cylinder having a journal at each end. These, being supported by the housing of the machine, hold the core in a horizontal position. The cylinder is fed with cooling-water, which enters through one journal to spray the upper side of its inner surface, and is siphoned out through the other. The cylindrical core has an intermittently turning movement; for seven-eighths of a complete action of the machine it is stationary, and during the other eighth is given a half turn and brought to rest. Thus, each of its two semicylindrical surfaces, or faces, is alternately beneath and above. Beneath the cylinder is a co-operating concave part, called the "back," which has a periodical up and down movement of about six inches. When in its uppermost position it embraces the lower half of the core, with space enough between the two in which to cast a plate of the desired thickness. For three-fourths of the machine's cycle of operation the back is in engagement with the core, after which it drops away, to permit the semi-rotation of the cylinder. The back, when casting is not being done, lies at rest in its lowermost position, ready to receive a matrix. At each of the straight sides of the back is a sliding bar carrying a spring-seated matrix-clamp. These bars are secured together and can be moved out or in after the fashion of a drawer. Extending from the back, towards the operator, is a concave continuation of the back, upon the straight edges of which these matrix bars run to their outermost position. This extension is called the loading tray. In it the matrix is laid to be put into the clamps. After the clamps have closed upon it, the clamps and the matrix together are slid into the space intervening between cylinder and back. Then the casting-lever is thrown down, and the parts of the casting mechanism go into operation; when the back, carrying clamps and matrix, closes up beneath the under side of the cylinder, and

the matrix is automatically positioned within the circle of the box. Thus, there is provided between core and matrix a semi-circular space equal in length, breadth, and thickness to the size of the plate to be cast. At one of the straight ends of this space,

FIG. 14.

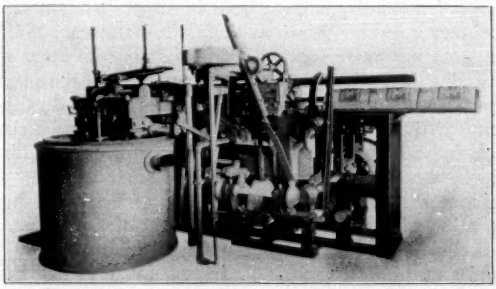


Cooling the Plate Before Sending it to the Press.

and completely closing it, is the long straight mouth of a pump-spout. Through this spout, rising from a pump which is immersed in a cauldron which usually holds 12,000 lbs. of molten stereotype metal, the charge of metal is sent immediately into

the casting space described the instant the back has formed it. The opposite straight side of the casting chamber having already been closed by the matrix-clamping bar carried at that side by the back, the space is sealed and the charge of metal injected (about 40 pounds) is securely held until it has been cooled by the water-chilled cylinder and back. As the pump plunger is operated by a cam-compressed spring, which continues to apply pressure to the metal in the chamber during its solidification, the shrinkage of the cast is minimized. In the Autoplate machine metal is usually run at 475° Fahrenheit, and a half-inch plate requires about ten seconds in

FIG. 15.



The Autoplate Machine—rear view.

which to solidify. Therefore, after ten seconds of dwell the pump plunger is released, and draws down from the mouth-piece all the molten metal it contains, thus leaving nothing but the cast to be dealt with when the chamber is opened. So sharp is the line at which congealation ceases, an inch above the head of the plate, that after the remaining molten metal has run back into the pump cylinder, and the plate has been ejected, no metal, either in molten or solid form, is left in the mouthpiece to cause clogs, or other difficulties. The cast being hard, the back descends and the matrix-retaining clamps, which are spring-controlled, gently strip the flexible matrix from the plate. This still adheres to the under side of the cylindrical core about which it has been cast. So soon as the stripping of the matrix is finished—a

delicate operation, performed with great dexterity and speed by the machine—the cylinder is caused to make its half-revolution, and the plate is brought thereby out of its position beneath the cylinder to that above it and comes to rest. Then the back, with its matrix, once more closes against the under side of the cylinder, the pump acts, and another plate is cast; this time upon the reverse side of the core. Meanwhile the first cast has been lifted from the top of the core and pushed along, upon its straight edges, between two horizontally rotating saws, making 3500 R.P.M. These remove the narrow sprue cast upon one straight edge of the plate, and the narrower over-cast portion at its other straight edge, and trim the plate at both edges close up to its type surface. After passing the saws the plate goes beneath the dome of a shaving arch, where it comes to rest. Into the smooth inner curve of this it is then lifted and clamped, and a straight, rotating knife promptly smoothes out its inner surface ribs, bringing it thereby to proper thickness. As the process of shaving gives the plate not only its thickness, but also the exact curvature of the press-cylinder upon which it is to be clamped, it is most important that it be accurately performed. This is insured by having the parts of great strength and accuracy, and by passing water through the arch-casting. The latter prevents the distortion of the arch, and consequently of the plates, which would occur if the shaving-arch were permitted to accumulate heat, and expand. At each end of the shaving knife is fixed a small hook-like chisel. This reaches over the bevelled edge of the plate, made roughly in casting it, and trims the edge close to the type. By this time a second cast has reached the "shaver," as that device is called, and the first plate, being finished, is drawn out by an arm and passed over a wetting apparatus. By means of the latter the plate is given a final cooling, from its inner side only, which leaves the type side try. The plate, now finished and cold, is ready for press.

The fundamental principles of the Autoplate machine may thus be set forth:

The cast, being made upon the under semi-diameter of a cylindrical core, may be quickly and easily ejected by a half-turn of the core. This arrangement permits of a double speed in casting, as two core surfaces are alternately used—the one having opportunity to cool while the other is in use. It further pro-

vides two natural postures for the work of casting and delivering the plate. Thus the plate is cast with its printing surface beneath, which insures a good face; and upon its ejection from the casting chamber is left face up, resting upon its two straight edges, in position to be most easily mechanipulated.[3] Moreover, as the operation of casting the plate occupies but the under part of the core, and that of delivering it from the core occupies only its upper part, both functions may simultaneously take place. This greatly increases the celerity with which the machine may be worked.

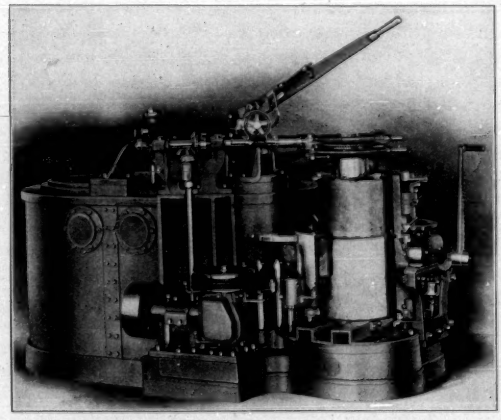
The matrix is mechanipulated: the mechanism used for the purpose acting with a gentle, uniform motion, to position the matrix with accuracy for each cast to be made, and to strip it from the resulting cast without injury of its delicate texture. Thus as many as one hundred casts have been made from one matrix.

Several safety appliances are embodied in the machine. One consists of a stud with a V-shaped nick which is cut to surround its middle portion. This stud, being inserted in a hole common to two adjacent elements of the driving mechanism, serves to communicate from one to the other the power furnished to drive the machine. As the nicked portion of the stud lies at the point of juncture of these elements, and its nicked section is of sufficient strength to transmit the necessary power, it will serve under normal conditions to drive the machine. But as the nicked section of the safety pin, as this is called, is weaker than the weakest part of the machine, it will instantly give way if the machine be obstructed, and the machine will then come at once to rest. The obstruction having been removed and another pin inserted work may immediately be resumed. As Autoplate machines were to be used by workmen unskilled in the care and use of automatic machinery such a safety device became necessary. Error-preventing appliances, also, are employed. By means of these it is not possible, for instance, to insert the matrix-clamping mechanism in the casting chamber unless, the matrix being inserted, all its parts are in proper position; nor is it possible to start the

[3] In my experience I have frequently felt the need of a word which should express the "handling" of its work by a machine, as the word *manipulate* expresses the handling of the work of a man by his hands. To fill the gap I have made bold to coin and use the word *mechanipulate*, which is here employed.

casting mechanism to work until the matrix-clamping device is safely and properly positioned in the casting chamber. During operation the matrix device cannot be withdrawn from the chamber, for in order that it may be withdrawn casting must first cease. While the casting chamber is open, and the matrix parts are out of position, the pumping system is under restraint, so molten metal cannot, by any carelessness of a workman, be ejected. The Autoplate machine has so successfully been made "foolproof" that a mishap is an extremely rare occurrence.

FIG. 16.



The Junior Autoplate Machine—which casts, cuts the riser from, and delivers 3 plates a minute. These have subsequently to be shaved and cooled.

Autoplate machines cost $25,000 each. The *New York Herald* has three, the *New York World* four, the *New York Times* two, the *Chicago Daily News* four, and the *Tribune* of Chicago three. Other large newspapers throughout America, Great Britain, and Europe, also, have them in use. Many instances of pay-roll savings, ranging from $30,000 to $40,000 a year, may be set to the credit of this machine; while in the saving of time, a still more valuable consideration, some surprising results have been achieved. One of the largest New York

daily newspapers, for instance, is now closing its type-pages twenty minutes later than it formerly could, and whereas its whole battery of presses used to require an hour in which to be set to printing, it is now got to work in less than fifteen minutes. The gain of this particular newspaper may be summarized as: a yearly saving of over $40,000 in wages; twenty minutes of added time in which to gather news and advertisements; and the ability to get all of its presses running some forty minutes earlier than formerly, which enables it to catch earlier and more trains and thus vastly to extend the area over which it circulates. In addition to these advantages this newspaper has been able to increase its selling time on the street, and greatly to improve its typographic appearance.

Coincident with the adoption of the Autoplate machine by the dailies of the larger cities there arose a demand, from newspapers of lesser magnitude, for a similar machine suitable to their needs. This was supplied in the Junior Autoplate, a very much less expensive apparatus, but one built upon Autoplate principles. Several functions, in the parent machine automatically performed, in the Junior Autoplate were assigned to attending workmen. The cylindrical core was stood on end and, with the back, which was similarly positioned, was given additional length to provide a sprue of sufficient height to insure the pressure necessary for perfect casting. In this machine the casting space was left open at its upper—its curved—end and was filled from an over-hanging spout by means of a hand-worked pump, immersed in a 10,000-lb. pot of molten metal. The back was moved to and from the core by a hand-worked lever, and after the cast had cooled and the back had been drawn away, the operation of a hand-worked clutch-lever set the cylinder to making a half-turn, by power. As in this case the plate was "poured" at one of its curved ends, its straight sides required no subsequent sawing; nor did they require hand-dressing, because of the fact that the matrix-edges and the clamps were made of such shape that all protrusions at the straight-edges, save only the type itself, were cast below printing height. But the riser, which constituted the upper curved portion of the cast, as in the case of a hand-made plate, had to be removed. This was done during the half-turn of the cylindrical core which turned the cast out of the casting chamber. Two saws were then thrown into position ahead of the plate,

one at the height of the upper edge of the printing plate itself, and the other opposite its lower bevelled edge. As the cast passed these saws one severed the sprue from the plate while the other trimmed its lower edge. Small pockets in the cylinder surface, into which the metal of the cast had run, acted during the sawing operation to hold the sprue and plate securely to the cylinder, where these continued to cling after they had been sawn apart. The cylinder having come to a stop, the back, with the matrix, was again closed upon its rearmost side, and another charge of metal thrown into the casting chamber. While this was being cooled by the water-circulation of cylinder and the back, the workman removed the first sprue and, after tossing it into the pot, removed the first cast. This he dropped into the old, conventional shaving device, and planed it out in the usual way After having been shaved, dipped, and dried by hand the plate was then ready for use. The freeing of the sprue and cast from the cylindrical core, it should be remarked, was accomplished by means of a slight blow delivered by the straight edges of the back when closed for a succeeding cast. Thus freed from the core the plate was left standing upon a shelf, upon its lowermost curved edge, whence it was removed by hand. The sprue, still held to the cylinder by a couple of pins, from which it hung, was easily removable by hand. Two unusual engineering practices were necessary in this machine. The saws, making 4000 R.P.M., had to be driven to cut in the same direction as the cast moved. This was done so that their dust should not be thrown into the casting-chamber to prevent its making a tight joint at closing. The upper saw had to be set to cut directly against the iron of the cylinder. Both were successfully accomplished, and have since worked without trouble. But one further feature of the Junior Autoplate machine need be mentioned—the device employed to inform the workman when to open the casting chamber. In hand casting it is left to the operator to determine just when the cast is sufficiently hard to be removed. Thus, much time is unnecessarily lost. It was to save this waste of time that an announcing mechanism was applied to the Junior. It consisted of a gong and a slowly driven toothed wheel, by a notch of which a spring-pressed clapper could be engaged and cocked. A cam-like piece secured to the framing, but adjustable about the centre of the wheel, was provided to trip the spring-pressed clapper at

any given point which might be chosen, and permit it to fly back and strike the gong. Thus, if the tripping-cam were set at a point to reach which it required the notch of the wheel that held the clapper-lever ten seconds of time, the gong would be sounded ten seconds after the clapper had been thrown into engagement with that notch. From the handle of the pumping mechanism used to fill the casting chamber depended a finger, which acted to cock the clapper at the moment the pouring stroke of the pump lever occurred. By this arrangement the gong, if its cam were adjusted to allow the normal time required to cool a cast, made from metal at a given temperature, could be depended upon accurately to announce the arrival of the moment at which the cast should be removed. To set this device it required merely a knowledge of the speed with which the particular metal used solidified.

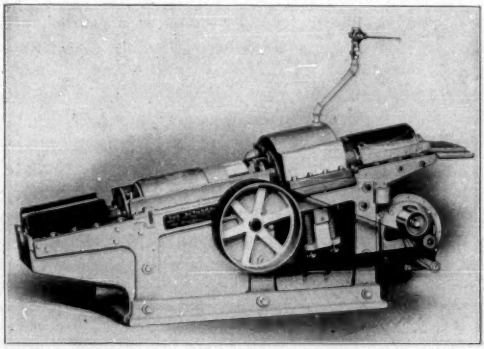
In the Junior Autoplate, it will be observed, the fundamental principles of the Autoplate machine recur: the matrix is stripped and repositioned without the intervention of the eyes or hands of the workman; casts are successively made upon alternate sides of a cylindrical core; a half-turn of the core simultaneously ejects a cast and presents a fresh casting-surface; and the closing of the chamber frees the preceding cast from the core so that it may thereafter be removed during the succeeding casting operation. In the Junior Autoplate, however, a new principle, among other, minor ones, is to be found: the cast is cut from its sprue while both are attached to the core, by means of a saw working in conjunction with the latter. The rate of production of the Junior Autoplate machine is three plates a minute. Its plates however, as delivered by the machine, are not wholly finished but require thereafter to be shaved, dipped, and dried.

In many instances newspapers have purchased not one but several Junior Autoplate machines. This has led to the construction of the double Junior, which consists of two Junior Autoplates attached to an elliptical pot, one at each of its ends. The pot employed is usually of 16,000 lbs. capacity. The machines are made right hand and left, and are independent of one another. Such an equipment requires the use of two matrices, one for each machine, and its rate of production is six plates a minute.

Having finished the construction of the double Junior Autoplate, a new apparatus called the Autoshaver was next provided,

to shave, cool, and deliver, dry, the plates made by Junior machines. This consisted of an inclined run-way of stud-supported, flanged wheels, along which the plate might run by gravity, upon its straight edges. At the upper end of this runway was a receiving station, its exit barred by a cam-worked gate. Next along the route of the plate came a shaving arch, it also having at its lower end a cam-worked gate; then below the shaving arch a water-saddle, the exit of which was likewise barred and, finally, beyond this a receiving station beneath which rotated a

FIG. 17.

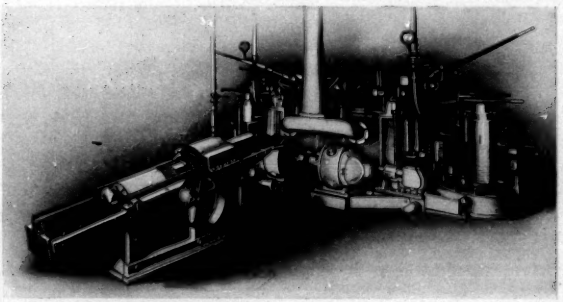


The Autoshaver—which shaves, cools, and delivers, ready for press, plates made by the Junior Autoplate. Its capacity is 6 plates a minute, which enables it to serve two Junior machines.

brush, to clear the plate of such water as might adhere to its under side. Driven by the operating mechanism of the machine were cams, which worked the gates, a constantly rotating shaving knife within the arch, clamps for therein securing the plate, and the brush. The shaving arch was cooled as in the Autoplate by the circulation of water, which went thence to the water-saddle. There, over a series of riffles, the water broke into cascades so arranged as to compel it to contact with the inner side of the plate, which it cooled. The Autoshaver made six revolutions a minute, and was capable of receiving a plate at each revolution. To use it it was only necessary that a plate from

a Junior should be placed and left on the receiving stand, with its straight edges on the wheels of the run-way. At the proper moment the first gate opened and let the plate run into the arch, where the second gate arrested it. There it was clamped and shaved, and at the proper moment released to run out and onto the water-saddle. After having been there held for an instant, and cooled, it was released by the last gate, and ran forward to the delivery stand where, being brought to rest by a stationary stop, it was brushed out, and thereafter stood ready to be sent to press. Having a capacity of six plates a minute the Autoshaver

FIG. 18.



The Double Junior Autoplate-Autoshaver Equipment—which consists of two Junior machines attached to one furnace, and an Autoshaver capable of finishing their product. Capacity, 6 printing plates a minute.

was capable of finishing the product of a double Junior Autoplate machine. Thus, it has become the custom to install with every double machine, an Autoshaver. The *New York American*, for instance, uses three such equipments, having a combined capacity of eighteen finished plates a minute. In this newspaper office its Autoshavers are so arranged that their finished plates are taken from them by automatic carriers to the various press-rooms in which they are to be used. Thus, a stereotyper touches a plate but once, in transporting it from Junior to Autoshaver.

In concluding the subject of the evening, it may lend a touch of human interest to what has been of necessity but a dry relation

of mechanical facts, if I state that nearly $2,000,000 worth of Autoplate machinery has been sold at home and abroad; and that it has been carefully computed that in the United States and Canada there is now being made by its use a yearly saving of over $350,000.

In this address I have sought, as clearly as might be, to sketch the mechanical progress of the newspaper from its beginning to the present day. But I have not undertaken the fascinating task of forecasting its future. It is, indeed, strange that, having all the facilities I have described, the most progressive newspapers of the time still feel themselves to be as heavily handicapped as could ever have the newspapers of old. But such is the case. The incentive to progress still exists, and the rewards to be won in the future are even greater than were those of the past. In the press-room, I am fully convinced, will come the next great advance.

TUNGSTEN IN 1909.

PRELIMINARY STATEMENT BY THE GEOLOGICAL SURVEY.

The production in the United States in 1909 of tungsten concentrates reckoned at 60 per cent. of tungstic trioxide was 1958 short tons, valued at $746,130, according to figures compiled by F. L. Hess, of the United States Geological Survey, from returns received from producers. These figures represent the exact production for the first eleven months of the year plus the estimated production in December. Of this amount Boulder County, Colo., produced 1401 tons, valued at $550,280.

LARGEST PRODUCTION RECORDED.

In 1908 the total production was 671 short tons, valued at $229,955, and there was therefore an increase in 1909 of 1287 tons in output and of $516,175 in value, or about 200 per cent. Although it is difficult to make exact comparisons of production for different years owing to the fact that before 1906 no effort was made to estimate the ores at a common degree of concentration, yet the tonnage of 1909 was the largest yet recorded and the value of the product was exceeded only by that of 1907, which was $890,048.

PRICES.

The average price per unit for the whole amount produced in the United States in 1909 was $6.50. In the early part of 1907 the price was $14, but it dropped to $9, and later to $5, and was still lower for most of 1908.

THE AUTOPLATE MACHINE.

[Report of the Franklin Institute, through its Committee on Science and the Arts, on the Autoplate, a mechanism for producing stereotype plates, invented by Henry A. Wise Wood of New York City. Sub-Committee: Louis E. Levy, Chairman; Harvey M. Watts, E. M. Ericsson, William L. Loveland. No. 2397.]

THE autoplate is a mechanism for producing stereotype plates suitable for use on the fast-revolving cylinders of newspaper printing presses. By means of this invention the flexible papier maché matrices moulded from flat forms of type are made to deliver castings of stereotype metal, in the form of curved plates, by a mechanical process which is practically automatic and which produces these plates with a uniformity of perfection and at a rate of speed heretofore unattainable.

Application for a patent on this device was made by the inventor on March 4, 1898. The basic patent was issued on February 17, 1903, and was supplemented by six other patents, all of the same date, the numbers running consecutively from 721,117 to 721,123 inclusive. The machine was introduced to practice in 1900 and has achieved a recognized position in the art.

In the prior art of making curved stereotype plates from papier maché matrices, the finished product is the result of a series of operations performed by means of a number of separate appliances worked manually by a gang of operatives. Apart from the inevitable pot of molten metal, these appliances include: (1) A heavy iron casting-box supported on trunions and consisting of a jacketed concave cylinder, to which a convex counterpart is so hinged that when closed the two surfaces are parallel at such distance apart as to leave the space requisite for the thickness of the casting. (2) An iron table with convex surface, known as a "plate horse," and adapted to receive the curved casting with its convex side up, for the trimming of the straight sides. (3) A machine for sawing off the tail and bevelling the curved ends of the plate and at the same time shaving its bottom to an exact thickness and an accurate concave surface.

Where these appliances are to be operated with all possible dispatch a gang of six operatives, two at each machine, is

necessary. Two of the men manipulate the casting-box, which at the start has to be heated to a considerable degree—this is usually by making a number of blank casts. They then adjust the flexible paper matrix, with the mould-side inward, in the curved hollow of the casting-box, while it is fixed horizontally on its trunions, then bring the heavy convex cover down into position over the concave matrix and fasten it securely in its place, and then turn the closed box back on its trunions into a vertical position, its upper end being open to receive the molten metal. This, in the most advanced practice, is made to flow into the box from the down-curving mouth of a pipe reaching to near the bottom of the adjacent melting pot, whence it is forced up through the pipe by a pumping device. The metal having filled the mould, cold water is run through the jacket of the casting-box and quickly turned off. The box is then turned down on its trunions to its horizontal position and the heavy cover is lifted up.

Two of the men now take up the casting, with its adhering matrix, from the hollow of the box and place it convex side up on the nearby plate-horse; here one of them strips the matrix from the cast and hands it back for a repetition of the casting, and both proceed to trim the side edges of the one in hand. This done, the two men next life the casting from the plate-horse and clamp it in the hollow cradle of a shaving machine in which the edge of a broad knife is made to pass in horizontal revolution over the concave surface of the plate to shave it to exact thickness while at the same time a fast-revolving milling tool bevels the edges to fit the plate for the clamps by which it is held to the cylinder of the press.

Working with all practicable speed, this system turns out the completed product at the rate of about one plate per minute, though in a spurt of rush a few plates can be produced at the rate of two plates in three minutes; but even at the normal speed of manipulation, the handling of the hot castings, weighing from 40 to 50 pounds, under the strain of haste in the heated atmosphere surrounding the great pots of molten metal, exhausts the workmen in a few hours of labor.

In the production of a daily paper the very fact that the work must be accomplished from beginning to end within but a fraction of the day makes every step of the proceeding a race against

time. When it is further considered that the product must be ready for distribution by each of the various agencies of transportation,—the express trains, the mail service, and the individual carriers,—at a definite moment of time, it becomes apparent that these latter moments are the determining factors of the entire situation. If 100,000 copies of the publication are to be distributed, and these are to be finished on a quadruple press, say at the rate of 25,000 per hour, then the printing must be given a four-hour start; that is to say, the last of the stereotype plates requisite for the operation of the press, the so-called "starter" plates, must be done four hours before the last copy is printed. Each quadruple press requires four stereos of each page to "dress" it. If, as is practically necessary, the time is to be shortened, more presses must be operated, and correspondingly more stereotypes of each page will be needed. To reduce the press-work time to one hour, four quadruple or two octuple presses must be operated an average of one hour each, the first one, "dressed" with its full complement of plates, starting ahead and running longer than the one which is last to receive its "starter" plate. If now, 16 pages are to be printed, there will be needed 16 duplicates of each form, 256 stereos in all. At the rate of one per minute, this would mean over four hours time; the first form would then have to be closed and in the hands of the stereotypers four hours ahead of the last. The exigencies of the case make this practicable only with a few pages of the paper, such as the editorial and some of the advertising pages; those presenting the news of the day must be kept open to the last possible moment, which means simply the increase of the stereotype plant and the number of men operating it. Moreover, the last stereo of the last form, the "starter," takes 8 minutes to reach the first press and 16 minutes to reach the second press, and where the edition runs larger, a still further loss of time to reach the other presses, all waiting, the huge complicated machines and their crews of 12 or 14 men each, all standing idle to receive their "starter."

Under that system a solution of the problem presented to the newspaper publisher required either the omission of the latest news or additional plant and operatives in the stereo room and additional presses and operatives in the press-room. It can scarcely be imagined, and not at all described, what a strain

and commotion pervades the stereotype room of a newspaper as the moment of going to press approaches and the "starters" are being rushed through, and when the last of these has been completed on a hot summer night it not infrequently happens that one or more of the overstrained workmen drop to the floor in utter exhaustion and have to be carried from the room.

Such was the state of the art in 1900, when after six years of toilsome effort Wood's invention of the autoplate was put to work. Its purpose was to give more working time to the great plant of machinery in the newspaper press-room and to replace the strenuous labor of the workman by automatic machinery, and it not only accomplished these ends, but produces its results in a quality as perfect as the matrices can be made to deliver with the most painstaking process of manual labor.

The task undertaken by Mr. Wood was virtually the invention of a series of machines so composed as to produce the completed plate by the automatic operation of the successive mechanisms. The crux of the problem lay really in the manipulation of the flexible matrix, particularly in the production of adequate means for mechanically stripping it from the curved surface of the casting in such manner as to preclude all danger of its being frayed in the process, and in providing effectually for its automatic readjustment in place for the succeeding cast. Beyond this were the requirements for supplying the metal to the mould and for trimming, bevelling, and shaving of the plate. The concept of these devices was at hand in the apparatus already in use, but the co-ordination of the various appliances into an organized series of mechanisms that should automatically handle the heavy curved plate with great rapidity in the succeeding operations was in itself an undertaking of serious magnitude.

The first patent for this invention, that of February 17, 1903, includes practically all of its essential features, the subsequent patents covering only various modifications of the first mechanism. The primary element is the device for manipulating the matrix in the curved casting-box, and consists of an arrangement in the nature of a frame, composed of two longitudinal bars connected at their ends by semicircular spring strips, curved to conform to the bottom of the concave casting-box. The flexible matrix, bent into corresponding form, is secured along its straight sides by clamps against the side bars, the spring strips resting on

the curved surface of the matrix and along its ends. The side bars of the frame are provided with dovetails fitting into grooves near the horizontal edges of the casting-box, permitting the frame, with its contained matrix, to be brought into its proper place in the box, and into proper relation to the cylindrical core of the box. The casting is now effected by forcing molten metal, by means of a pump, from the adjacent melting pot through a spout into the space between the matrix and the core. This done, cold water is turned on to flow through the jacketed exterior of the casting-box; the metal quickly solidifies and the water-current is cut off, so as not to cool the casting-box unduly. The box is composed of two segments, hinged on a pivot so that when closed they form a continuous concave surface of the curvature required for the plate, and which, widening out when they are opened, correspondingly flatten the curve described between them. The segments are movable in relation to the core, moving away from it as they open out and returning to their normal place when closed.

The cast having solidified, the two sections of the box open out, and the matrix, held by the side bars along the horizontal sides of the opening box, is thereby stripped away from the curved plate along its two straight sides, and the entire box moving away from the plate, the combined movement results in peeling the matrix from the plate along its sides and in pulling it straight away from the plate at the apex of its curve.

This stripping and removal of the matrix from the cast and its subsequent readjustment in place are distinctly the most essential features of the autoplate machine, and are effected with uniform precision, the mechanism being one of remarkable ingenuity.

The plate being free from its matrix, the cylindrical core makes a half turn to move it out. In the course of this movement the plate is carried past a saw which cuts away its gate-tail, and coincidentally both curved ends are trimmed on the requisite bevel. While this is going on the casting-box closes and moves the matrix into proper place in relation to the core, and another casting is made. The plate meanwhile proceeds automatically to an apparatus that shaves its concave surface to exact thickness for the press cylinders, and so the various operations follow in succession with such rapidity that the plates can be produced

and delivered by the machine at intervals of twelve seconds, and are never slower than four per minute.

The autoplate is, in fact, a congeries of mechanisms so combined as to automatically effect a number of distinctly different operations. The machine in its most developed form is a large and costly affair, adapted principally for the requirements of the great metropolitan newspapers. To meet the needs of establishments of lesser magnitude, Mr. Wood has devised the so-called junior autoplate, in which the essentials of the larger machine are combined on a less complex plan, having in view the production of plates at the rate of about three per minute. The mechanism of the junior autoplate is remarkably simple as compared with the larger machine, and it fulfils the requirements of all but the great daily publications for which the larger machine was designed.

Latterly, the autoplate machine has been developed by its inventor to a yet greater efficiency. In its latest form it produces plates at a rate of nearly seven per minute, from a single matrix, and a device has been added for completely cooling the plate when finished, so that it need not be dipped by hand in water for that purpose, and a further device for drying the plate, so that it need not be given its final wiping, as has always heretofore been done by the pressman before he puts it on the cylinder. There is also being added an automatic carrier between the machine and the press-room, so that the plate will now go to press without having to be touched by the hand of the operator, and at a speed heretofore regarded as impossible.

The autoplate has indeed wrought a revolution in the mechanical work of newspaper production, no less important in the economy of daily journalism than that brought about when the linotype machine supplanted the composing stick in the hand of the compositor.

Fully recognizing the great service which the invention of the autoplate machine has rendered to the progress of the typographic art and the importance of this invention in the development of modern journalism, the Franklin Institute awards to its inventor, Mr. Henry A. Wise Wood, the Elliott Cresson medal and diploma.

Attest: JAMES CHRISTIE,
Secretary.

June 3, 1908.

ELECTRICAL SECTION

(Stated meeting held Thursday, November 18, 1909.

THE ELECTRICAL REDUCTION OF IRON ORE.

BY

JOSEPH W. RICHARDS,

Professor of Metallurgy in Lehigh University; Secretary of the American Electrochemical Society.

[The application of the electric current as a source of heat energy in the reduction of iron ores would but a short time ago have scarcely been seriously considered. Its possibility has however been more than demonstrated. In this paper, Dr. Richards describes the work of several investigators in the development and operation of this method of manufacturing pig-iron on a practical commercial scale.]

THIS topic is one which a few years ago could only have been discussed in a speculative manner, and by one with the prophetic gift highly developed. The reduction of iron ore by means of the energy of fuel, in blast-furnaces, is carried on on such a stupendous scale and with such great economy that the blast-furnace has been frequently called our most perfect furnace, and the possibility of electrical energy taking any part in this industry appeared highly visionary. When electric furnaces commenced to be developed on a commercial scale, it was generally admitted that if they entered the iron industry at all their best chance was in the production of highly expensive special quality steels, costing $500 to $1000 per ton, and that their poorest chance would be to compete in the manufacture of pig-iron costing $10 to $15 per ton. Yet inside of five short years, those who have watched the development of the electrical iron and steel industry have seen small furnaces turning out fine steels succeeded by larger ones manufacturing successfully common steels, such as steel castings and rail steel, and finally the operation of a larger electric shaft furnace manufacturing pig-iron on a practical commercial scale.

Confining ourselves this evening to the electrical production of pig-iron, most of the credit for the recent advances should

be given to the far-sighted interest of the Canadian Government in this subject, principally, under the influence of its active Director of the Department of Mines, Dr. Eugene Haanel, of Ottawa, and to the enterprising Swedes, principally Assar Grönwall, Axel Lindblad and Otto Stalhane, who have founded the company "Aktiebolaget Electrometall" of Ludvika, Sweden. If to these we add the names of H. H. Noble, of the Northern California Power Company, and his able assistant, Prof. D. A. Lyon, who have constructed and operated an electric pig-iron furnace in California, the list of *active* workers in this field is nearly complete.

EXPERIMENTS OF THE CANADIAN COMMISSION IN EUROPE.

When, in January, 1904, the Canadian Government sent a commission, under Dr. Haanel, "to investigate the different electro-thermic processes for the smelting of iron ores and the making of steel in operation in Europe," the commission found and reported upon a number of different electric-steel furnaces in commercial operation, but found not a single electric pig-iron furnace at work. From the voluminous and most valuable report of this Commission (published by the Canadian Government, August, 1904) we learn that, being interested in seeing what might be accomplished in this direction, several of the European works were persuaded to make some experiments on the production of pig-iron. Some of these tests are described briefly in the following extracts from the report:

At La Praz, France.—"Mr. Héroult was good enough to make some experiments for us in smelting iron ores. The furnace employed was exceedingly simple." . . . "These experiments were made for us by Mr. Héroult for the purpose of demonstrating the simplicity of the process of reducing iron ores by the electric process and it was not intended to demonstrate a figure of cost per ton of pig-iron produced by this process." It appears from the data given that this test was very crude and poorly arranged. Too little carbon for reduction was used in the charge, the furnace was run too cold, and the power consumption ran up to 0.525 h. p. year per ton of pig-iron obtained.

At Livet, France.—The works of Keller-Leleux et Cie. possessed furnaces constructed for the reduction of ore, and used

for manufacturing ferro-silicon and ferro-chromium. These were placed at the disposal of the commission, and two long runs made of 55 and 48 hours each, with all the data carefully controlled and checked. The complete details of these runs can be found in the report of the commission. Illustrations of the furnace used may be seen in the report. It is of the resistance type, with two shafts, each with its vertical electrode embedded in the charge, and connected by a well in which metal and slag collect. The current passes from the electrodes to carbon blocks embedded in the base of the furnace. The lining was a rammed-in mixture of dolomite and tar, similar to that of a basic-lined Bessemer converter. The electrodes were square, 280 mm. (11 inches) on the side and 1400 mm. (56 inches) long. The 55-hour run was interrupted to put in a wattmeter, and the metal set in the furnace, so that the power consumption for this run 0.52 h. p. year per metric ton of pig-iron, was abnormal. In the second run of 48 hours no interruption occurred, the furnace "working quietly, and without the slightest accident; the gases discharging on top in flickering flames, showing that the gas resulting from the reduction of the ore escaped at low pressure. The workmen were ordinary Italian laborers, without any special training."

This second run was successful in producing, at will, different classes of pig-iron, gray, white, and mottled, and in setting a definite figure for the amount of electric energy required per ton of pig-iron produced. The furnace was nominally of 300 h. p. capacity, but running with 350 h. p.; it consumed 0.25 h. p. year per metric ton of pig-iron produced, using 41 per cent. of fuel. This is a satisfactory figure, and is partly attributable to running the furnace hard, *i.e.*, over its normal capacity.

EXPERIMENTS OF THE CANADIAN GOVERNMENT AT SAULT S. MARIE.

On the return of the Canadian Commission from Europe, and the publication of its report, the Canadian Government placed at the disposal of Dr. Haanel and his staff $15,000 for investigating the suitability of the electric process for reducing Canadian iron ores. The experiments were carried out early in 1906, and may be found recorded in detail in the report

published by Dr. Haanel in February, 1907 (Ottawa, Mines Branch, Department of the Interior). An analytical discussion of these experiments and the results obtained was presented by the speaker to the American Electrochemical Society, at its meeting in New York City, October 18, 1907, and published in the *Transactions* of that Society, vol. xii, p. 81. The furnace used is shown in Fig. 1. The following conclusions from the author's analysis may here suffice:

1. Too much carbon was used in every case, not allowing a good utilization of the heat of oxidation of carbon in the furnace. A *smaller* proportion of carbon, more perfectly consumed to CO_2 would have generated *more* heat and thus have helped the furnace more.

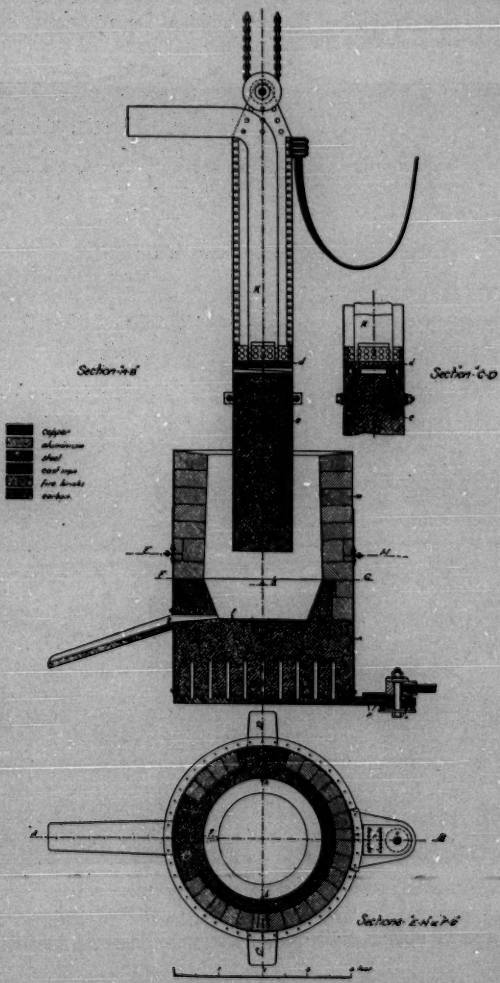
2. The electric current furnished about two thirds of the energy required for all purposes, the carbon one third.

3. The consumption of fixed carbon was 24 to 38 per cent. of the weight of pig-iron, giving ratios of CO to CO_2 in the gases of 4.5 up to 9 (by volume); whereas a ratio of 1 is possible, would require far less carbon, and would produce more heat in the furnace. For the details of this analysis, the reader is referred to the original paper. Some of these figures will be used in the comparative tabulations at the end of this paper. One thing is particularly worth noting: the Sault Ste. Marie furnace was small and was worked hard, a condition favorable for small conduction and radiation loss, and economy of power.

RUNNING OF THE SWEDISH SHAFT FURNACE.

The experiments at Sault Ste. Marie bore fruit first in Sweden, by inciting experimenters there to construct a large electric shaft furnace for the regular commercial production of pig-iron. Messrs. Grönwall, Lindblad and Stalhane conducted preliminary experiments at Ludvika, Sweden, in the summer of 1907, with a small furnace of 300 h. p. capacity; in the summer of 1908 a larger furnace of different type was constructed, and in the autumn of 1908 a still larger furnace, embodying the results of all their experience, was completed. This furnace was designed for 1500 kilowatts, and may be truly termed the pioneer electric pig-iron furnace. The best description of this furnace and its working are to be found in a paper by Dr. E. Haanel in the *Transactions of the American Electro-*

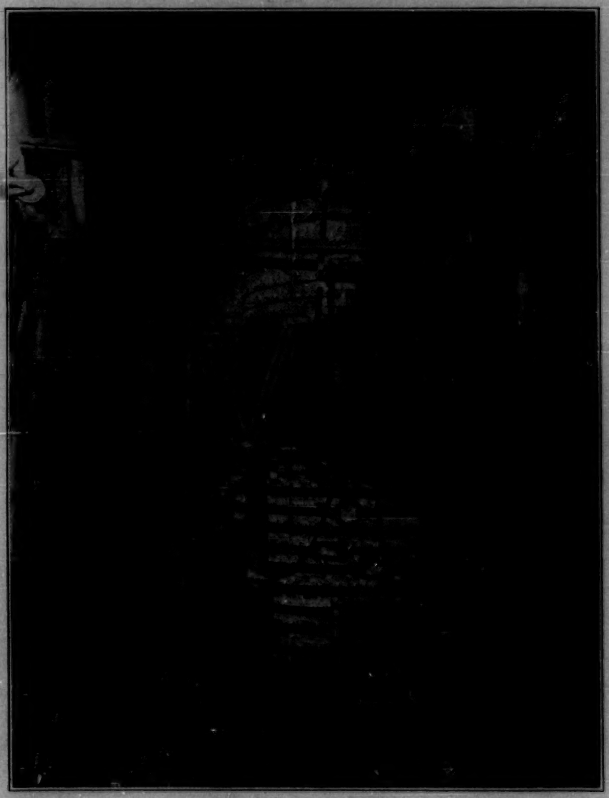
FIG. 1.



Experimental furnace used at Sault S. Marie.

chemical Society, vol. xv, p. 25, and in the subsequent report of Dr. Haanel published by the Canadian Department of Mines,

FIG. 2.



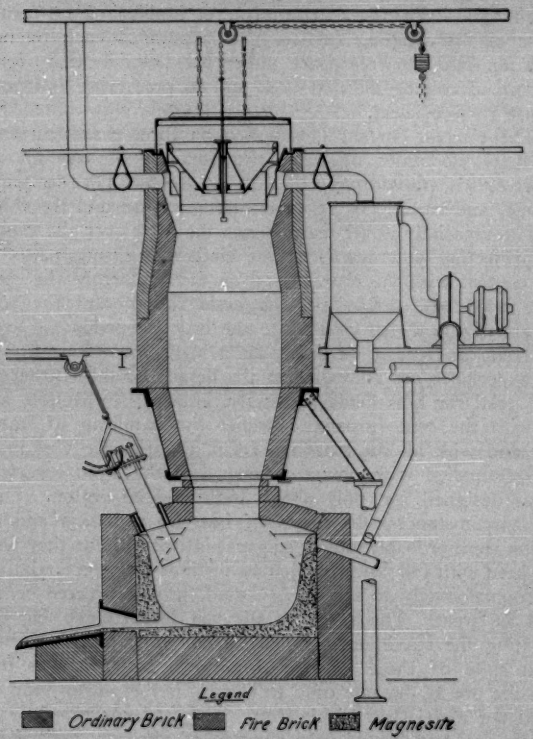
Electric shaft furnace at Ludvika, Sweden.

in October, 1909, entitled "Investigation of an Electric Shaft Furnace at Domnarfvet, Sweden. The following details and

illustrations (Figs. 2 and 3) are taken from Dr. Haanel's publications:

The total height above the ground-level is 25 feet; the

FIG. 3.



Section of Ludvika furnace.

crucible is 7 feet high, the shaft 18 feet. The entire weight of the upper shaft is carried on six cast-iron columns—none of it rests on the arch covering the crucible. This arched roof has

openings for the three electrodes, each composed of two carbons 11 in. square by 63 in. long, making each electrode 11 in. by 22 in. by 63 in. The electrode holder is a steel frame into which the electrodes are fastened by copper wedges. The electrodes pass through water-cooled stuffing boxes. The crucible is lined with magnesite-brick—a material never usable in blast-furnaces. Some of the escaping furnace gas is pumped back by means of a fan into the free space under the crucible arch, for the purpose of cooling off that arch and so preserving it from the intense radiated heat.

The electric current is supplied as three-phase current to the three electrodes by three transformers of 500 kilo-volt-amperes each, transforming the current down to 1/14 its primary voltage, and capable of regulation between 20 and 85 volts.

The especially novel features are the arch over the crucible, the projecting downwards of the electrodes through this arch into contact with the charge as it spreads out from the central shaft into the crucible, the magnesia lining, and the return of part of the throat gases into the crucible under the arched roof. It can readily be seen that a large amount of thought and experience are embodied in the details of this furnace.

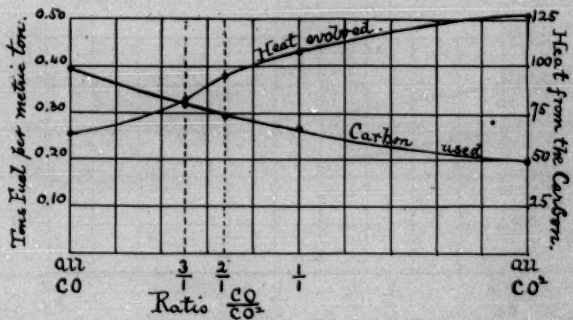
A trial run was made under Dr. Haanel's inspection, starting with the cold furnace. Besides the handicap of starting cold, and with all the masonry fresh, the furnace was insufficiently supplied with power. Instead of the 1500 kw. which it was designed for, only about 400 could be gotten. Under these circumstances, the losses of heat by radiation and conduction were probably almost so great intrinsically as they would have been with full power, which means that they were relatively, or proportionately to the energy used, probably three or four times as great. The result of the test is therefore far from indicating the maximum commercial efficiency of this furnace.

In spite of these adverse conditions, pig-iron was made from the ore at the rate of 0.40 electric horse power year consumed per metric ton of pig-iron. The fuel consumed for reduction was 27.5 kg. of coke per 100 of pig-iron, and of electrodes 5 kg. It is altogether reasonable to assume that the power consumption, when in regular running, will not exceed 0.3 e. h. p. year, and on this basis, counting power at $12 per e. h. p. year and charcoal (83 per cent. carbon) at $8.00 per

metric ton (2204 lbs.), Professor Odelstjerna, of Stockholm, has estimated that pig-iron can now be made, in Sweden, in this furnace, at $1.50 per ton less than in Swedish blast-furnaces. It is my opinion that this furnace, if run at 3000 kw., could make pig-iron at 0.2 e. h. p. year per ton of output, making a further saving of $1.20 per ton. With a prospective saving of $2.50 per ton, the Swedish blast-furnace industry stands a good chance of being superseded by the electric furnace, as soon as the latter gets into proper working order.

Accompanying diagrams are intended to illustrate the fundamental principles of electric furnace reduction of iron ore.

FIG. 4.



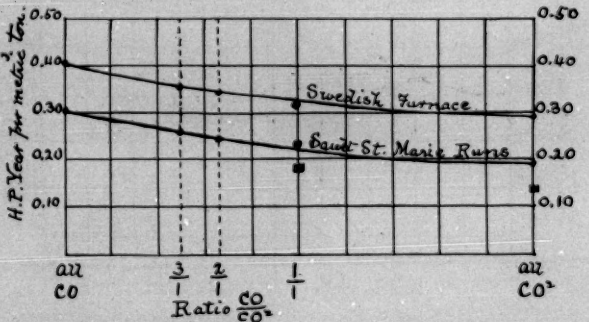
Variation of fuel required and heat evolved, with composition of waste gases produced.

They are entirely dependent upon the rate at which the furnace is run and the proportion of CO to CO_2 in the gases. In the latter respect, a proportion of 1 : 1 by volume is entirely practicable and should be attained in electric smelting, although 2 : 1 is the usual ratio in blast-furnace practice. A kilogramme of oxygen burning carbon to CO gives up 1820 heat units (calories), but if burning (only half as much) carbon to CO_2 it gives up 3075 calories. Since there is a definite amount of oxygen to be removed per ton of pig-iron made, more assistance is obtained from the combination of carbon and oxygen the more CO_2 and the less CO is formed. Fig. 4 shows the heat evolved, in units of 1000 calories, as the ratio of CO : CO_2 varies from all

CO to ratios of CO to $CO_2 = 3$, 2 and 1, and extended to the supposed case of all CO_2 being formed. It shows graphically the fact that the smaller the amount of carbon used the more heat obtained from its oxidation, because it is being burnt by a fixed quantity of oxygen.

Experiments on the reduction of iron oxides in currents of CO gas render it improbable that a lower ratio of $CO : CO_2$ than 1 : 1 can be obtained in practice, even under the most favorable electric furnace conditions. This corresponds to 0.26 ton of carbon per ton of pig-iron made, and a thermal assistance from the carbon of 1,111,500 calories (1750 horse-power-hours) per ton of iron.

FIG. 5.



Variations of power required, with composition of waste gases produced.

Fig. 5 shows the variation of horse power required per ton of pig-iron with the ratios of $CO : CO_2$ in the gases. It shows distinctly how wasteful of power it is to run a furnace with too much carbon; with a certain amount of carbon charged it is practically impossible to utilize it except it burns mostly to CO, and then the high power consumption is the result of the lack of proper thermal assistance from the carbon. The power curve of the Swedish furnace is above those of the S. S. Marie runs, for the same fuel consumption or ratio of $CO : CO_2$, because the former furnace was being run at not over one-fourth, possibly nearer one-sixth, of its proper power supply, while the

latter furnace was small and was pushed hard. The difference of 0.1 h. p. year per ton of pig-iron made is probably entirely ascribable to high radiation and conduction losses, due to the relatively slow running.

THERMAL ANALYSIS OF RUN OF SWEDISH SHAFT FURNACE.

Dr. Haanel gives sufficient data for forming a good idea of the heat distribution in the large Swedish furnace. The data are as follows:

Composition of ore	Fe	= 62.96 per cent.
Composition of coke	C	= 85. per cent.
	S	= 0.55 per cent.
	Ash	= 14.45 per cent.
Composition of slag	SiO_2	= 26.54 per cent.
	CaO	= 54.48 per cent.
	S	= 0.78 per cent.
	Fe	= 0.35 per cent.
Composition of pig-iron	Fe	= 94.485 per cent.
	C	= 3.20 per cent.
	Si	= 0.075 per cent.
	Mn	= 0.33 per cent.
	P	= 1.90 per cent.
	S	= 0.01 per cent.
Composition of gases	CO_2	= 25.00 per cent. by volume.
	CO	= 65.00 per cent. by volume.
	H	= 10.00 per cent. by volume.

Charges: Ore, 220; Coke, 37.4; Lime, 4.4.

From the above data it can be calculated, assuming the gases escaping at 250° and the pig-iron and slag at a little above blast-furnace temperature, that the energy received and distributed by the furnace is about as follows, per 100 kg. of pig-iron concerned:

HEAT DEVELOPED.

Carbon oxidized to CO	52,318	calories.
CO oxidized to CO_2	44,785	calories.
Formation of slag	2,058	calories.
Carburization of iron	2,256	calories.
Total heat of chemical reactions	101,417	calories = 31 per cent.
Heat energy of 0.041 e. h. p. year	223,171	calories = 69 per cent.
Total available energy	324,588	calories.
Average required in blast-furnaces	400,000	calories.

HEAT DISTRIBUTION.

Reduction of iron oxide.....	155,221 calories	= 48	per cent.
Reduction of other oxides.....	10,174 calories	= 3.5	per cent.
Evaporation of water.....	1,025 calories	= 0.3	per cent.
Sensible heat in waste gases.....	4,075 calories	= 1.3	per cent.
Sensible heat in pig-iron.....	32,500 calories	= 10.0	per cent.
Sensible heat in slag.....	8,600 calories	= 2.7	per cent.
Rad'n and cond'n loss (diff.)....	112,850 calories	= 33.2	per cent.

The last item of the above schedule is very much larger than it should be. Some modern blast-furnaces run with one-tenth that much. The trouble with this furnace was that it was run only about one-tenth as fast as it should be for heat economy. If we assume that this furnace is run fast and carefully, so as to get a ratio $CO : CO_2$ in the gases of 1 : 1, we can estimate what will be the probable running of a large electric pig-iron furnace, such as will undoubtedly be in steady operation in the near future. The requirement for power will be that necessary to furnish the needed heat, less that furnished by the chemical reactions. These will be, per ton of pig-iron produced:

Needed for reductions.....	1,655,000 calories	= 2600 h. p. hours.
Sensible heat of pig-iron.....	300,000 calories	= 470 h. p. hours.
Sensible heat of slag.....	60,000 calories	= 100 h. p. hours.
Radiation and conduction.....	100,000 calories	= 160 h. p. hours.
	2,115,000 calories	= 3330 h. p. hours.
Furnished by chemical reactions	1,111,500 calories	= 1750 h. p. hours.
Needed from electric current..	1,003,500 calories	= 1580 h. p. hours.

The following is therefore the conclusion of this investigation:

If a larger electric shaft furnace is run rapidly, with abundant power, and the gases escaping contain at least as much CO_2 (by volume) as CO, the minimum power requirement which will be approximated is 1580 h. p. hours, or 0.18 h. p. years, per metric ton (2204 lbs.) of pig-iron produced.

One ton per 0.226 h. p. year has already been reached in an experimental run.

THE TESTING OF EXPLOSIVES FOR SENSITIVENESS TO SHOCK BY THE DROPHAMMER METHOD.

BY

DR. H. KAST,

BERLIN.

[Translated from the *Zeit. für das gesamte Schiess- und Sprengstoffwesen* for July 15, 1909. By W. J. Williams, F.I.C.]

THE Royal Military Experimental Bureau of Berlin has been occupied for the last 20 years in the examination of explosives for military purposes. The degree of the sensitiveness to shock of these explosives is of great significance in regard to their availability. Hence the testing of their sensitiveness has always been of great importance in the investigations of this bureau.

Professor Lenze, at the last congress in Rome, reported exhaustively on the accumulated results of these investigations, so that it is unnecessary to refer to them further.

It need only be remarked that experience has shown that the drophammer must not be allowed to act directly on the explosive, chiefly for the reason that the sensitiveness, as ascertained by means of the drophammer, depends in the greatest degree on the area of the struck surface, and it is not possible to keep the struck surface unchanged under the direct action of the drophammer.

If the drophammer is allowed to act directly, or indirectly through an interposed piston, on an uneven layer of the explosive spread directly on the anvil, the area of the struck surface will change in proportion to the varying thickness of the layer in different spots. But then it is impossible to obtain strictly proportional values, because the percussive energy is distributed over surfaces of different area.

This drawback can be avoided by interposing a contrivance between the drophammer and the anvil, which is so arranged that only a strictly defined surface is exposed to the blow.

This contrivance must comply with the following conditions:

1. The surface to be struck must be a definite and invariable area.

2. The explosive must be so arranged that it cannot spread out sideways.

The chief aim in the examination of the explosive is to bring those properties into prominence which are determined by its physical condition (state of aggregation, softer or harder consistency, plasticity, fusibility, density). Therefore the explosive should be tested in a layer of defined thickness, but otherwise unalterable, both in the fluid and solid state, and at a suitable temperature.

For example guhr-dynamite and gelatin-dynamite are more sensitive than blasting gelatin; powdered explosives are more sensitive than grained explosives; colloided gun-cotton powders are less sensitive than gun-cotton; chlorate explosives, enveloped in soft, plastic substances, are less sensitive than those prepared without such envelopes; nitro-glycerin is less sensitive than dynamite.

3. Any frictional action of the blow must be avoided as carefully as possible, as explosives behave quite differently under friction to what they do under percussion.

Thus the chlorate explosives are more sensitive than dynamite to friction, but less sensitive to percussion.

Further the explosives must not be rubbed between hard materials. For this reason it is not permissible to add frictional materials (powdered glass, sand) for the artificial augmentation of the sensitiveness to shock in the comparison of dissimilar explosives, since that would affect the natural ratios of explosives sensitive to friction too seriously.

Special methods are used for testing the sensitiveness to friction.

4. There must be a constant increase of sensitiveness with the height of the fall.

5. The limits of sensitiveness must be the same whether the tests are made starting with a low fall up to a higher, or the reverse.

In the ordinary way of testing this is by no means always the case; it is very frequently observed that quite different limits are recorded when the fall starts low and is increased, than in reverse order, starting high and ending low. The reason for this variation is that in the latter case the drop-weight and the anvil are heated to a greater degree both by the explosives and

by the conversion of the energy of the blow into heat, hence the explosive is, to some extent, tested at a higher temperature, in the latter case.

6. The values found at different times must agree with one another within certain narrow limits; and in particular the ratio of the sensitiveness towards that of the explosives with which it is compared must be constant.

7. The force of the blow developed with different weights for the given limit values must be about the same; but it must also be recognized that by the use of different weights the ratio of sensitiveness is somewhat changed, on account of the different physical properties of the explosive, the varying velocities of impact,[1] and the different dissipation of the kinetic energy because of the greater rebound of the lighter weights.

Explosives which can easily evade the blow (*e.g.*, fluids like nitro-glycerin) show themselves more sensitive to a light, swift-acting weight than to a heavier weight.

8. Sharp differences should be observed with low falls, since experience shows that these differences are less marked as the height of the fall increases.

9. Proportionally insensitive explosives should also be tested comparatively.

10. It must be determined, beyond any doubt, whether the explosion is entire or only partial, or whether the explosive has merely burned; from these results conclusions can be drawn as to the danger of unexpected detonation induced by shock.

Care must be taken that the layer of the explosive exposed to the blow is not too thin, as this renders explosion more difficult.

In the ordinary way of testing, the air-waves from the drop-weight, and those produced by partial explosion, blow away the explosive, especially when pulverulent, so that the sample appears to have been completely exploded.

These conditions are best fulfilled by the apparatus[2] now to

[1] The end velocity of the drop-weight amounts to 0.99 metres with a 5 cm. fall, to 3.43 metres with a 60 cm. fall; the duration of influence with a 1 mm. stamp is 0.001 seconds for 5 cm. fall, and 0.0003 seconds for 60 cm. fall.

[2] For diagrams of the apparatus see Zeit. Schiess- und Sprengstoffwesen 1, 289 (Fig. 5) 1906. Reports Rome 2, p. 529, Fig. 6, 1907. Kast, Anleitung zur chemischen und phys. Untersuchung der Spreng- und Zündstoffen, p. 1015, Fig. 238.

be described. It has been used for the last 4 years in the Military Experimental Bureau expressly for testing sensitiveness, and has shown itself to be reliable. The most convenient form, and the dimensions of the different parts, have been developed from a series of experiments. The apparatus has the following merits:

1. The striking surfaces are exactly one half a square centimetre (0.0775 sq. inch).

2. The separate parts can be accurately adjusted.

3. It is light and easy to clean,[3] and to remove the residues of the explosive.

4. The separate parts can be easily replaced if they are damaged or too much worn.

5. The drop must not exceed 60 cm. (2 ft.) (see table below) for the most insensitive explosives.

6. The required quantity of explosive can be easily measured in the apparatus itself or can at least be easily judged.

7. Any special reaction of the explosive is easily recognized.

The following precautions must be observed in using the apparatus:

1. It must be so arranged that both the stamps fit the ring without any play, and the ring must move easily up or down the stamps.

2. The stamps must be well hardened, so that they do not upset (burr) with use, and do not crack.

3. Both striking surfaces must be ground smooth, and must be exactly 8 mm. (0.315 in.) in diameter.

4. Three different apparatuses must be used in succession in each experiment, so that any erratic action of one or the other may be detected. The apparatuses must be fixed in a cylindrical bed on the anvil to avoid damage from the drop weight.

After measuring out the prescribed quantity, the explosive is pressed together by twisting both stamps so that there is an even layer over the whole surface.

5. The experiment must be effected at a definite temperature —from 18° to 20° C. is best.

[3] With certain explosives, such as the easily fusible nitro-compounds, it frequently happens that the fused matter is pressed in between the stamp and the ring, and this binds the stamp. In that case a vice or a pipe-wrench is necessary to withdraw the stamp. This causes no difficulty in the use of the apparatus.

6. An apparatus which has become hot from use is cooled down to the experimental temperature.

7. At least two different drop weights must be used. The choice of weights is regulated by the sensitiveness of the explosive.

The maximum drop is:

For 2 kg. (4.4 lbs.)	60 cm. (2 feet)
For 5 kg. (11.0 lbs.)	30 cm. (1 foot)
For 10 kg. (22.0 lbs.)	24 cm. (9 3/5 in.)
For 20 kg. (44.0 lbs.)	20 cm. (8 inches)

These are sufficient for all cases. Besides the use of higher drops soon spoils the apparatus.

8. The experiment is conducted by making six trials at each height, and repeating these twice on each apparatus.

9. The effect on the explosive is accurately defined. The different points are:

A. No action.

B. Slight action, *i.e.*, the appearance of smoke, a smell of burning, explosion without audible report.

C. Explosion, subdivided into: (*a*) slight explosion, *i.e.*, slight report; (*b*) strong explosion, *i.e.*, loud report; (*c*) complete explosion.

10. The height is to be decreased until no action follows in any single instance, and is then raised until either the limit of height for the given weight is reached, or a complete explosion is obtained in all six trials.

11. The limit of sensitiveness is held to be that height from which, in as nearly as possible in an unbroken series, at least one single distinct explosion occurs.

If two different explosives have their limit of sensitiveness at the same height, that height at which explosion *occurs regularly* is to be taken as the distinctive standard height.

12. The experiments must be carried out twice, on two different days.

13. Special peculiarities must decide the quantity of explosive used. In the tests of the Military Experimental Bureau an average quantity of 0.04 gramme (0.62 grains) is used, which is measured out in a small cup (primer cap).

FRANKLIN INSTITUTE

REPORT OF THE BOARD OF MANAGERS FOR THE YEAR ENDING SEPTEMBER 30TH, 1909, WITH APPENDICES EMBRACING THE ANNUAL REPORTS OF THE VARIOUS COMMITTEES AND SECTIONS.

To the Members of the Franklin Institute:

The Board of Managers herewith transmits the reports of its Committees on Instruction, Elections and Resignations, Stocks and Finance, Publications, and Sectional Arrangements, and of the Curators, for the Institute year ending September 30, 1909.

What is probably the most important work of the Institute's year, outside of the regular routine of the various committees, finds expression in the changes in the By-laws, which have been voted upon to-day. These changes in part create a new class of membership, which we believe will result in an extension of the usefulness of the Institute, and an increase in the number of its members. They provide for an increase in the number of the Institute Managers by one—from 24 to 25—the additional member to be elected by the Alumni Association. They provide for the election of the Secretary, and the appointment of members of the Science and Arts Committee by the Board,—thus centralizing the responsibility for the conduct of the routine work of the Institute. They make various changes in the methods of procedure by the Science and Arts Committee, which it is believed will increase the efficiency of the Committee, making the work more attractive to men of ability,—reducing the clerical work to be done by them, so that hereafter men serving on this Committee will find the work of higher class, more commensurate with their abilities than heretofore, and therefore more attractive. The Chairman of the Science and Arts Committee will be ex-officio a member of the Board.

These are the principal changes proposed and we believe them to be very important and valuable.

I am pleased to report that the Alumni Association of the Institute, which was mentioned in our last Annual Report, has organized and is in a healthful condition. The Association has 89 members. We believe that the interest of the Alumni in the Institute will be fostered and the Institute's work materially aided by this organization.

During the year the Board has lost by death Dr. Persifor Frazer, whose service on the Board dates, with an intermission, from January, 1880. Dr. Frazer's "interest in the Institute may be said to have come as a heritage." A memorial to Dr. Frazer appears in the JOURNAL for July, 1909.

The status of the proposed new building for the Institute is practi-

cally as it was at the time of the last Annual Report. The Institute has available a fund of $331,000, and its equity in this building—about $65,000. This is enough for the erection of a suitable and sufficient building, but not for the purchase of a site on the Boulevard and the erection of a building monumental in character. We have hope that the City will give us an appropriate site on the Boulevard, in which event work on the building will be begun almost immediately. In the meantime, the fund, which is in the hands of the City Trusts, is invested and increasing.

It would be very satisfactory to provide a better home for the Institute, but if the time comes to leave this building the parting will be with regret. This old building has been the scene of much work of the highest class. From it have gone out to the work of the mechanical world, hundreds of boys much benefited by the instruction here given them, and through that benefit largely benefiting industrial Philadelphia. This old building has been the centre of work that has been extensive and useful far out of proportion to the moneys expended, and due to the intelligent self-sacrifice of our predecessors. It is an honored building, and its work is known in every centre of scientific thought the world around. While we remain here may our work be worthy of the old home, and of our honored predecessors—if we leave may it be to make the new home a worthy successor to the old. We cannot presume to wish more.

For the Board of Managers,

WALTON CLARK,
President.

PHILADELPHIA, January 19, 1910.

REPORT OF THE COMMITTEE ON INSTRUCTION.

To the Board of Managers:

Your Committee on Instruction begs to report as follows:

Early in the spring of 1909, it was considered advisable to reorganize the curriculum of the Schools connected with the Institute.

After numerous meetings, Mr. William H. Thorne—who has for many years been associated with the Schools, and upon whose energy and ability their success has largely depended—was appointed Director of the Schools, having for his able Assistants:

Messrs. Lucien E. Picolet, Principal of the School of Machine Design; M. H. Keil, Principal of the School of Naval Architecture; John Loman, Instructor in Algebra; H. E. Hutchins, Instructor in Geometery and Trigonometry; Clement Remington, Principal of the School of Architectural and Free-Hand Drawing; I. P. Pedrick, Assistant Instructor in Elementary Drawing; and W. W. Twining, Assistant.

Through the generosity of one of the Trustees, your Committee was enabled to introduce individual instruction in mathematics for such of the students as required it. The plan has proved most successful, and the Committee feel confident it has filled a long needed want.

A table is herewith submitted showing the attendance during the Winter

Term of 1908, the attendance for the Spring term of 1909 and the attendance for the Winter Term of 1909.

	1908 Winter Term	1909 Spring Term	1909 Winter Term
Drawing	94	79	98
Mathematics	39	15	41
Strength of Materials	9	7	17
Machine Design	5	5	5
Naval Architecture	8	3	12
	155	109	173

The Popular Lectures last year were delivered at the Hall of the Young Men's Christian Association, and were as follows:

Nov. 16, 1908—"IN THE HEART OF THE CUMBERLANDS," Dr. Geo. A. Hubbell.

Nov. 30, 1908—"OUR NATURAL RESOURCES," Their Utilization and Conservation, Mr. John Birkinbine.

Dec. 14, 1908—"OUR ITALY, (SOUTHERN CALIFORNIA)," Prof. Oscar C. S. Carter.

Dec. 28, 1908—"THE MEASUREMENT OF SOUND," Prof. A. G. Webster.

Jan. 18, 1909—"SNAP-SHOTS OF THE CATHEDRALS OF ENGLAND," Messrs. W. N. Jennings and Chas. K. Stokes.

Feb. 1, 1909—"THE WORK OF THE FOREST SERVICE," Mr. Bristow Adams, U. S. Dept. of Agriculture, Washington.

Feb. 15, 1909—"IDENTIFICATION STUDIED WITH ALPHONSE BERTILLON," Persifor Frazer, Dr. ès Sci. Nat. Philadelphia.

March 1, 1909—"THE NATURAL GAS INDUSTRY," Mr. J. C. McDowell, Prest. Natural Gas Association of America.

It was decided by the Committee to engage Witherspoon Hall, at Walnut and Juniper Streets, for a "Course of Popular Lectures", and the following dates and lectures were arranged for:

Oct. 15, 1909—"NAVIGATING THE AIR," Mr. Augustus Post, Sec'y Aero Club of America.

Nov. 12, 1909—"QUALITY OF LIGHT," Mr. Paul F. Bauder, National Electric Lamp Association.

Dec. 10, 1909—"PERILS OF PEACE OR A SAFER AMERICA," Dr. W. H. Tolman, Director of the Museum of Safety and Sanitation, N. Y.

Jan. 28, 1910—"ROAD ADMINISTRATION AND MAINTENANCE," Mr. Logan W. Page, Director Office of Public Roads, Washington, D. C.

Feb. 11, 1910—"RECENT METHODS FOR THE PRODUCTION OF LIGHT," Dr. Robert H. Bradbury, Southern Manual Training High School, Philadelphia.

March 14, 1910—"A SUMMER VACATION IN FOREIGN LANDS," Messrs. W. N. Jennings and Charles K. Stokes, Philadelphia.

Respectfully submitted,

LAWRENCE T. PAUL,
Chairman.

PHILADELPHIA, Pa., January 12, 1910.

REPORT OF THE COMMITTEE ON ELECTIONS AND RESIGNATIONS OF MEMBERS.

To the Board of Managers:

The Committee on Elections and Resignations begs leave to state that during the last fiscal year 45 Resident Members and 18 Non-resident Members were added to the Membership, a total of 63.

During that period resignations were presented and accepted from 29 Resident and 32 Non-resident Members. There was also one Life Member elected.

This would show a net gain of Resident Members of 16, and a net loss of Non-resident Members of 14.

Respectfully submitted,

ALEX. KRUMBHAAR,
Chairman.

PHILADELPHIA, Pa., January 12, 1910.

REPORT OF THE COMMITTEE ON STOCKS AND FINANCE.

To the Board of Managers:

FINANCIAL STATEMENT.

October 1, 1908, to September 30, 1909.

PROPERTY AND FUNDS.

Building and Land, 13-17 S. 7th St.		$44,000.00	
Library		100,000.00	
Apparatus, Collections and Models		5,022.49	
			$149,022.49
Funds held by Board of Trustees—	Principal.	Unexpended Income.	
General Endowment Fund	$52,550.50		
Building Fund	531.00		
Chemical Periodicals Binding Fund	100.00		
Elizabeth M. Graff Fund	4,092.12	$133.48	
Journal Endowment Fund	138.00		
M. Carey Lea Fund	2,000.00	35.01 (credit)	
Edward Longstreth Medal Fund	1,000.00	337.16	
James T. Morris Memorial Fund	5,000.00	481.61	
Potts Library Fund	952.50	18.31	
Potts Medal Fund	1,000.00	48.84	
Funds held by the Board of Managers—			
B. H. Bartol Trust Fund	1,000.00	75.00	
Boyden Premium	1,000.00	277.16	
H. W. Jayne Library Fund	500.00*		
B. H. Moore Memorial Fund	15,000.00	9.80	
New Building Fund	4,863.50°		
New Building Endowment Fund	115.00		
Endowment Fund, Memorial Library	1,000.00†	16.16†	

Fund held by the Board of City Trusts—			
Franklin Institute Building Fund	$331,350.77		
Fund held by Elliott-Cresson Trustees—			
Elliott-Cresson Medal Fund	1,000.00	3,303.48	
Total Funds	$423,193.39	$4,665.99	427,859.38
Grand Total			$576,881.87

* Entire principal merged with general funds of the Institute.
° Entire principal merged with general funds of the Institute.
† Entire principal and income merged with general funds of the Institute.

LIABILITIES.

Certificates of Stock—			
First Class	$35,130.00		
Second Class	390.00		
		$35,520.00	
Mortgage on Institute Building (held by Trustees as investment for Funds)		4,325.00	
			$39,845.00
Bills Payable—			
Girard National Bank		$4,000.00	
Franklin Fund and Building Committee		10,000.00	
Loans contracted in 1902 to meet deficit, notes for which are still held by original payees		2,150.00	
Loans contracted in 1902 and 1903 to meet deficit, the notes for which are now held by Building Committee		3,150.00	
			19,300.00
Life Memberships (owed to Board of Trustees)			3,835.00
Accounts Payable			1,430.01
Unearned Income—			
Advance Dues		$31.25	
Advance Tuition		592.18	
Advance Advertising		94.95	
			719.38
Grand Total			$65,129.39

INCOME AND EXPENSES.

Applicable to Year Ending September 30.

INCOME.

Dues	$8,969.97
Initiation Fees	55.00
General Endowment Fund	2,251.28
Estate of John Turner	112.49
Estate of Robert Wright	2,176.63

Donations		1,548.50
Income from Investments		58.00
Principal of Investments sold in excess of par		626.20
Miscellaneous		4.83
Membership Badges		19.02
Instruction: Tuition Fees		1,392.50
Publications: Subscriptions and Sales		2,146.07
Advertising		1,845.05
Total		$21 205.56

EXPENSES.

Building: Wages	$843.20	
Repairs and Maintenance	94.73	
Heat, Light and Power	633.04	
Taxes, Water Rent and Insurance	401.38	
Miscellaneous Supplies and Expense	241.98	
		$2,214.33
Elections and Resignations		305.55
Instruction		1,901.39
Library: Salaries	$1,237.70	
Books and Periodicals	1,457.04	
Miscellaneous Expense	334.54	
		3,029.28
Meetings: Printing	$76.03	
Miscellaneous Expense	186.62	
		262.65
Office and General: Salaries	$4,095.92	
Office Expense	266.95	
General Expense	883.14	
		5,246.01
Publications: Printing	$3,517.92	
Engraving	407.26	
Miscellaneous Expense	480.72	
		4,405.90
Science and Arts		248.36
Sections		397.41
Interest and Discount		583.62
Old Debts		2,409.60
Interest paid John T. Kille on donation to General Endowment Fund		200.00
Total		$21,204.10
Net Income		1.46

During the year the General Endowment Fund has been increased by $1200, $1000 being a donation and $200 a life membership. A Chemical Periodicals Binding Fund consisting of two shares of stock of the Frankford and Southwark Passenger Railway, has been received. The Franklin In-

stitute Building Fund comprises the money and securities turned over by the Institute to the Board of City Trusts added to the original Franklin Fund. Interest accretions add about $10,000 yearly to this fund.

The belief expressed last year that in the future receipts would exceed expenses did not prove true. The result of the past year's operations has been an increase in indebtedness of about $1000, and present appearances point to the same deficit this year, unless unexpected income is received.

Respectfully submitted,

WALTON FORSTALL,
Chairman.

PHILADELPHIA, Pa., January 12, 1910.

REPORT OF THE COMMITTEE ON PUBLICATIONS.

To the Board of Managers:

On the occasion of the completion of the eighty-fourth year and 168th volume of the JOURNAL OF THE FRANKLIN INSTITUTE, the Committee on Publications is enabled to report that this chronicle of the Institute's activities has during the past year gained further ground as an exponent of the applied sciences and as a vehicle of original contributions to their advancement. The high position of the JOURNAL in this respect has been quite fully maintained; the recognition accorded to it, both at home and abroad, has compassed a yet larger circle than ever before, and only the importance of sustaining its reputation as a journal of original scientific research and accomplishment has necessitated the curtailment or exclusion of much material from the present limit of its pages.

The wide dissemination of the JOURNAL to all the major and many of the minor centres of scientific activity throughout the world has been studiously continued and considerably increased during the past year. Its current issues are now regularly to be found in the reading rooms of practically every scientific body of importance at home and abroad. With this object in view the Committee has welcomed the requisitions of the Library Committee for increased numbers of the JOURNAL to go out in return for the publications of scientific bodies and in exchange for technical and scientific periodicals, recognizing the spread of the JOURNAL in this direction as a most important factor in the furtherance of its usefulness.

A gratifying feature of the past year's developments in the affairs of the JOURNAL is the considerable increase in its income from subscriptions and from sales of single copies, through demand coming from near and far. To this is to be added the equally gratifying increase of our advertising patronage, both facts pointing to an increasing appreciation of the JOURNAL as a medium of publicity. The result has been that notwithstanding the increasing size of the editions of the JOURNAL required for its members, subscribers and exchanges, the net cost of maintaining the publication has been gradually decreasing, thus affording a prospect of its ultimately ceasing to be a charge upon the resources of the Institute.

In this connection the Committee takes occasion to express its appreciation of the efficient services rendered by the Actuary of the Institute in the mechanical preparation and business conduct of the JOURNAL. It has been in a large measure due to his co-operation in this respect that the Committee has been enabled to prepare and issue a thoroughly revised edition of its Membership Directory which, including a compilation of the Charter and By-laws of the Institute, in a form more presentable than the earlier edition, was published in September of the past year.

Respectfully submitted,

LOUIS E. LEVY,
Chairman.

PHILADELPHIA, Pa., January 12, 1910.

REPORT OF THE COMMITTEE ON SECTIONAL ARRANGEMENTS.

To the Board of Managers:

Thirty-four meetings were held by the Sections during the year ending September 30, 1909, and considerable valuable material was obtained for publication of the INSTITUTE JOURNAL.

The work of the Sections was divided as follows:

Section of Physics and Chemistry	8 meetings
Electrical Section	8 "
Mining and Metallurgical Section	5 "
Mechanical and Engineering Section	7 "
Photographic Section	6 "

In addition to these meetings an exhibition of photographs made by members was held under the auspicies of the Photographic Section. The pictures were displayed in the reading room and remained on exhibition five days.

Your committee expresses its thanks to all who have assisted in making these meetings attractive and instructive.

Respectfully submitted,

JAMES CHRISTIE,
Chairman.

PHILADELPHIA, Pa., January 12, 1910.

REPORT OF THE CURATORS.

To the Board of Managers:

During the year the lower hall was entirely repainted. The stairs were also renovated to the second floor. The work was done by the engineer and the only cost was for materials—white lead, oils, etc.

A radiator was put into the smoking room in order that it might be more comfortable in extremely cold weather.

Four of the panels were removed from the lecture room doors and glass was substituted. This makes it possible to observe from the outside whether there is a meeting and adds to the appearance of the Hall, besides admitting light to the inside. Some slight repairs to the building were made during the year. The room on the South side of the Lecture Room will be fitted up for conversation and committee purposes. The glassware and models will be removed, the walls and floor painted, the stove replaced by radiators and a rug put on the floor. It is hoped that this improvement will be appreciated by all who visit the Institute.

More painting will be done during the coming Summer and it is hoped that it may be possible to have the Lecture Room renovated before next season.

Respectfully submitted,

CHAS. E. RONALDSON,
JAMES CHRISTIE,
Curators.

PHILADELPHIA, Pa., January 12, 1910.

REPORT OF THE LIBRARY COMMITTEE.

To the President and Members of the Franklin Institute:

The Committee on the Library respectfully submits the following report:

The following is a statement of the operations in the Library during the year ended September 30, 1909:

The following additions were made to the Library:

	BD. VOLS.	UNBD. VOLS.	PPHS.	MAPS.	PHOTO.	ENGR.
By Gift	481	390	891	3	7	1
" Journal	31	36	80	1		
" Binding	125					
" Exchange Account	7					
" General Appropriations	10	5				
" Mem. Lib. Fund		2				
" Moore Fund	108	25				
" Lea Fund	1					
" Morris Fund	35					
" Potts Fund	5	1				
	803	459	971	4	7	1

Total additions for the year, 2245.

Gifts of books and pamphlets in large quantities or of unusual importance were received from Messrs. W. D. Anderson, John E. Carter, Walton Clark, Morris Ebert, Richard Gilpin, Carl Hering, Robert Kitchell, Waldemar Lee, Morris L. Orum, C. J. Reed, Lewis S. Ware, Prof. L. M. Haupt, Drs. Wm. H. Greene and Samuel C. Hooker, Mrs. Samuel C. Hooker, the

United States Government, The Pennsylvania State Library, The American Philosophical Society, The University of California and the firm of Wilson Harris & Richards.

An unknown donor has given to the Franklin Institute two (2) shares of the capital stock of the Frankford & Southwark, Philadelphia City Passenger Railway, par value $50, selling September, 1909, at $396 each. The income amounting to $36 per annum is to be used for the binding of Journals printed in English, German and French, devoted especially to Chemistry.

The contents of the Library on October 1, 1909, were as follows:

Volumes, bound and unbound	64,089
Pamphlets	46,926
Maps and Charts	2,915
Drawings, design lithographs	783
Photographs	1,312
Newspaper clippings	192
Manuscripts	34

Books on deposit, 47.

DUPLICATES.

492 bound volumes, 147 unbound volumes, 3 pamphlets, and 165 magazines are in the duplicate collections of the Library. Two bound volumes were sold during the year.

BINDING.

The total binding done during the year was as follows:

New volumes of periodicals	125
Old paper books bound	5
Moore Fund books bound	21
Lea Fund	1
Potts Fund	1

PAMPHLETS.

Through the generosity of Mr. John T. Morris it has become possible to make a beginning in the cataloguing of the pamphlets. They are now being examined and all those relating to mechanics are being recorded and made ready for the shelves. The work is being done by a special assistant who has had some training in library work but no experience in cataloguing. All the pamphlets have not yet been gone over, and it is impossible to estimate how much time will be needed to finish the work.

PUBLIC DOCUMENTS.

By resolution of the Committee it has been decided to transfer all public documents not within the scope of the Institute's work to the Free Library of Philadelphia. The work of transfer was begun in the Fall but has been delayed by the Librarian's illness. Books which are likely to be of value to those who use the Institute's Library are being retained and communications will be addressed to the various technical departments of the Government, requesting that the Institute be placed on their mailing

lists for future publications. By the disposal of the documents which are not in demand, the Library will gain considerable shelf room, which is sorely needed for the proper care of the other works of the Library.

EVENING ATTENDANCE.

The Library was open on forty-four (44) evenings during the year until 10 o'clock, with a total attendance of 205 readers or an average of 4.6.

EXCHANGES.

Sixteen new publications were added to the list of exchanges and six were removed, making the total 580. One institution is still retained on the free list.

In the belief that our large collection of books is of more than local value, the Library Committee in December decided to publish the following advertisement:

"The Library of the Institute is prepared to undertake a limited amount of work in connection with the verification of references and copying from English, German and French books and periodicals. A moderate charge will be made to cover expense."

It is too early to expect results from this endeavor to extend the usefulness of our Library.

Finding lists would be convenient for those who use the Library and perhaps increase the number of readers, but no funds are available for the preparation of such lists.

The Committee on Library willingly conforms its expenditures to the amounts appropriated, but none the less looks forward to the time when by reason of a larger force of librarians, pleasanter rooms and the development of new lines of activity, the Library of the Franklin Institute will play a greater part in the intellectual life of the community about it.

Respectfully submitted,

GEORGE F. STRADLING,
Chairman.

PHILADELPHIA, Pa., January 10, 1910.

REPORT OF THE COMMITTEE ON MEETINGS.

To the President and Members of the Franklin Institute:

The Committee on Meetings arranged the following programme of subjects for the ten stated meetings of the Institute held during the year:

September Meeting, 1908: Mr. Henry A. Wise Wood, of New York, described his latest invention, the Autoplate Machine.

October Meeting: Mr. Henry W. Bartol spoke on the Vixen Milling File. Two brief communications were also presented.

November Meeting: The Telelectric Piano Player was shown and described.

December Meeting: Exhibition of the Telegraphone, and description of it.

January Meeting, 1909: The Automatic Electric Company installed in the lecture room one of their automatic telephone exchanges, and an address was delivered describing its operation.

February Meeting: Dr. W. S. Franklin, of Lehigh University, gave an experimental demonstration of the Gyroscope, and its application, with special reference to its use in the Brennan Monorail Car.

March Meeting: Mr. J. Kent Smith spoke on Vanadium and its application to the heavy arts; and Mr. Albert F. Shore described his Sclero-scope.

April Meeting: The Underwood Typewriter was described.

May Meeting: Mr. William Tatham read an interesting paper on the Panama Canal.

June Meeting: Mr. W. H. Fulweiler read a paper on Surfacing of Roads.

The attendance at these meetings was somewhat better than in the previous year, but the value and interest of the subjects presented, and papers read, should attract a still larger attendance from members and their friends.

It is urged that members call attention to the meetings as widely as possible, and avail themselves of the privilege of sending tickets to friends. Also that they send to the Secretary lists of names of persons, associations and business houses likely to be interested, to assist the Secretary in making up mailing lists for notices and distribution of tickets.

Respectfully submitted,

JAMES S. ROGERS,
Chairman.

PHILADELPHIA, PA., January 6, 1910.

REPORT OF THE COMMITTEE ON SCIENCE AND THE ARTS.

To the President and Members of the Franklin Institute:

It is with pleasure that the committee on Science and the Arts submits the following account of its operation for the year ending September 30, 1909:

The total number of cases on the record books September 30, 1909, was 60, of which 33 were carried over from the previous years. Twenty-seven new cases were added during the year. The number of cases disposed of during 1909 was 15. The number of cases pending September 30, 1909, was 70. The list of awards is appended hereto.

The Sub-Committee on Reorganization reported early in the year with their recommendations for increasing the efficiency of the Committee's work. The consideration of this report occupied considerable time outside of the usual routine work of the Committee, requiring a number of special meetings in order to complete the work and pass it on to the Board of Managers for their information and approval. We submit herewith a copy of this report and ask the approval of the same.

It is with great pleasure that the Chairman takes this opportunity to express his thorough appreciation of the faithful and loyal work done by his fellow members of the Committee.

Respectfully submitted,

JACOB Y. MCCONNELL,
Chairman.

PHILADELPHIA, PA., January 5, 1910.

APPENDIX.

DETAILS OF AWARDS, ETC.

AWARDS OF THE ELLIOTT CRESSON MEDAL.

2412. James Gayley for his "Dry Air Blast."
2413. Mad. Sklodowska Curie and in Memory of Pierre Curie for their "Researches Resulting in the Discovery of Radium."
2445. Alexis Vernaz for his "Milling Files."
2446. Benjamin Talbot for his "Open Hearth Steel Process."

AWARD OF THE JOHN SCOTT LEGACY PREMIUM AND MEDAL.

2436. Frank J. Wetzel for his "Automatic Mechanical Stoker."

AWARD OF THE EDWARD LONGSTRETH MEDAL OF MERIT.

2430. B. Frank Teal for his "Anti-friction Universal Joint.

REPORTS MADE ADVISORY.

2400, 2423, 2431, 2441, 2449, 2453, 2460.

PROTESTS.

2400. Previous findings reversed, advisory.
2429. No award.
2430. Previous findings sustained.

REPORT WITHOUT RECOMMENDATION.

2428.

SECTIONS

(Abstract of Proceedings of Stated Meetings.)

Mechanical and Engineering Section.—Stated meeting held Thursday, January 6, 1910. Charles Day in the Chair. Present, 29 members and visitors.

In the absence of the Secretary the reading of the minutes of the previous meeting was omitted, Chairman Day then introduced the speaker of the evening, Mr. C. A. Seley, who presented a paper entitled "Steel in Freight Car Construction." The lecturer reviewed the development of the use of structural steel for the underframing of freight cars and described how this led to the application for the superstructure of a structural steel truss system of framing, thereby securing greater strength and rigidity than had previously been obtained by the use of steel on the underframe alone. These features were adequately illustrated by lantern views showing the framing systems of gondola, hopper and box-cars and the completed cars as they appear in service.

At the close of the lecture the subject was discussed by Messrs. Stratton, Basford, Pomeroy, Day, Colvin and the speaker.

On motion of Mr. Colvin the subject was referred to the Committee on Science and the Arts and to the Committee on Publication and a vote of thanks of the Section was accorded the speaker. Adjourned.

LUCIEN E. PICOLET,
Acting Secretary.

Electrical Section.—Stated meeting was held January 13, 1910, with Mr. Thomas Spencer in the Chair. There were 47 members and visitors present.

The minutes of the last meeting were read and approved.

After regular business was transacted, the paper of the evening on "Electrical Methods and Results of Electric Testing," by Dr. Clayton H. Sharp, of the Electrical Testing Laboratories, New York, was read.

A vote of thanks was tendered the speaker for his paper.

There being no further business, the meeting adjourned.

RICHARD L. BINDER,
Secretary.

Section of Physics and Chemistry.—Stated meeting held Thursday, January 20, 1910, at eight o'clock in the evening, with Dr. E. Goldsmith in the Chair. Eighty-seven members and visitors were present. The minutes of the previous meeting were read and approved. Colonel B. W. Dunn, Chief Inspector of the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles, of the American Railway Association, presented a communication entitled "Promotion of Safety in the Transportation of Explosives and Other Dangerous Articles in the United States." Fatal accidents on railways due to the careless handling of dangerous freight were described and the necessity for uniform regulations for the transportation of such freight was emphasized. The origin, organization and work of the Bureau, as well as the co-operation between the railways and the shippers of explosives and similar articles, were reviewed. The lecture was copiously illustrated with lantern slides showing the proper and the improper manner of transporting dangerous materials, and the destructive effects of high explosives. The paper was referred for publication. On motion, duly seconded, the meeting adjourned.

JOSEPH S. HEPBURN,
Secretary.

FRANKLIN INSTITUTE

(*Proceedings of the Stated Meeting, held Wednesday, January 19, 1910.*)

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, January 19, 1910.

President WALTON CLARK *in the Chair.*

The annual meeting of the Institute was held this evening at eight o'clock, President Walton Clark in the Chair. There were present about forty members and visitors. The minutes of the last meeting were read and approved. The Actuary submitted the report of the Board of Managers, also the Committee on Instruction, Elections and Resignations of Members, Stocks and Finance, Publications, Sectional Arrangements, Library, Meetings, Science and the Arts, and the Curators, for the year ending September 30, 1909. These reports were printed and distributed among the members present and were duly approved by the meeting.

The Tellers submitted a report of the ballots cast for officers and members of the Board of Managers and of the Committee on Science and the Arts and for the amendments to the By-Laws. The following persons were duly declared elected to the respective offices:

President (to serve one year), Walton Clark.
Vice-President (to serve three years), Henry Howson.
Treasurer (to serve one year), Cyrus Borgner.
Auditor (to serve three years), Samuel P. Sadtler.
Auditor (to serve two years), John C. Trautwine, Jr.
Managers (to serve three years), Edwin S. Balch, W. C. L. Eglin, Alfred C. Harrison, Charles A. Hexamer, Alexander Krumbhaar, Charles E. Ronaldson, E. H. Sanborn, Walter Wood.
Committee on Science and the Arts (to serve three years) James Christie, G. H. Clamer, Walton Clark, Jr., Richard Gilpin, William O. Griggs, Charles A. Hexamer, Henrik V. Loss, Luther D. Lovekin, Thomas C. McBride, W. B. Riegner, J. Y. McConnell, E. S. Powers, J. W. Ridpath, L. F. Rondinella, Arthur J. Rowland, Thomas Spencer, William H. Thorne.

The amendments to the By-Laws as proposed at the December meeting were also adopted.

Messrs. Rogers, Sanborn and Rondinella offered further amendments to the revision which have for their purpose the rectifying of certain clerical errors and omissions. These were ordered to be sent to ballot for the next stated meeting of the Institute.

The paper of the evening was then presented by Dr. N. Monroe Hopkins of Washington, D. C., on the Dynatak, a gasoline engine, speedometer and dynamometer, the address being fully illustrated by lantern slides. On motion, the subject was referred to the Committee on Science and the Arts for investigation and report and a vote of thanks was offered to Dr. Hopkins for his interesting presentation of the subject. Adjourned.

JAMES CHRISTIE,
Secretary.

COMMITTEE ON SCIENCE AND THE ARTS.

(Proceedings of the Stated Meeting held Wednesday, January 5, 1910.)

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, January 5, 1910.

MR. J. Y. MCCONNELL *in the Chair.*

The Chairman presented a draft of the annual report of the Committee which was approved and ordered to be transmitted to the Institute.

The following report was presented for first reading:

No. 2473. The Underwood Typewriter.

In the absence of a quorum the report for second reading was not presented for consideration.

JAMES CHRISTIE,
Secretary.

FIRST RADIUM INSTITUTE.

The Austro-Hungarian Government is taking considerable interest in matters relating to *radium*, as will be seen from the following report made to the Department of Commerce and Labor:

A private donation of 500,000 crowns (about $100,000) some time ago made possible the erection of a new institute devoted to radium research in Vienna, which is now rapidly approaching completion. The building has four stories and will contain laboratories only, seven on each floor. This will be the first radium institute in the world and will have an international character, being at the services of scientists for purposes of radium research. Though the institute is donated by private munificence, the Government has undertaken the cost of maintenance.

The Ministry of Labor has hitherto been unable to accede to the many requests which have come from numerous sources, both inland and foreign, for radium. There was a certain quantity of it from Joachimsthal on hand, but it could not be sold until the exact percentage content of pure radium in the ore was established. The work of examination is now being carried on and the sale of radium will soon be begun. The radium will be sold in vials, each to contain 60 milligrammes of 5 per cent. radium or 30 milligrammes of 10 per cent. radium, the price of such a vial to be 1080 crowns (about $216), as the present market value of pure radium is estimated at 300,000 crowns ($60,000) per gramme. For the present only inland institutes will be sold to, and numerous applications from such are already on file. Many medical clinics have likewise made requests for radium in order to test its therapeutic value.

BOOK NOTICES

ANNUAIRE POUR L'AN 1910. Publie' par le Bureau des Longitudes. Over 900 pages, 6 x 3¾ inches with figures. Paper, price 1 franc 0.50 net, postage paid 1 franc 0.85. Gauthier-Villars, Paris.

This important annual publication contains this year, in addition to the usual astronomical data, tables on physics and chemistry comprising magnetic tables, corrections and comparisons of barometers and thermometers, expansion of liquids, vapor tension, elasticity and friction of solids, viscosity of gases, length of light waves, solubilities, etc. Of particular interest are the articles on the meeting of the "International Committee on the Protographic Celestial Chart" by M. Bailland, and "Land Tides and Elasticity of the Terrestrial Sphere" by Mr. Ch. Lallemand. L. E. P.

CONCRETE. By John C. Trautwine, Jr., and John C. Trautwine, 3d, Civil Engineers. First edition (first thousand), vii, 189 pages, 7¼ x 4¾ inches, cloth. Reprinted from Trautwine's Civil Engineers Pocket-Book, 19th Edition, 100th-thousand. Price $2.00 net. John Wiley and Sons, New York, 1909.

In recent years the use of concrete has increased enormously and its many applications with steel reinforcement to structures of every kind have required of designers the application of a branch of the statics of materials which has only relatively recently been available in a form to inspire confidence in the hands of the designer whose duties are not those of testing deductions but of using them. The accumulated fund of theoretical and experimental data is now very considerable and the authors have been able to find material for the revised edition of the pocket-book that has passed the purely experimental stage and received the test of application.

The ground is very fully covered and there is no department of the subject that is not included in the work. The authors have succeeded in presenting a large amount of invaluable data in small compass. L. E. P.

THE CIVIL ENGINEERS POCKET-BOOK. By John C. Trautwine, Civil Engineer; revised by John C. Trautwine, Jr., and John C. Trautwine, 3d, Civil Engineers. Morocco, xix, 1257 pages, 6½ x 4½ inches, 19th edition, 100th-thousand. Price $5.00 net. John Wiley and Sons, New York, 1909.

Among the reference books devoted to various branches of engineering practice there is probably none that can with better reason be regarded as a recognized standard in its field than "Trautwine." It is the product of a careful investigation and record of the best devices adopted and applied in engineering practice during a period of nearly forty years in the hands of compilers of high scientific attainment. It has now reached a circulation of 100,000 and, in its latest edition, through unsparing and consistent revision contains a condensed presentation of much data otherwise available only in a somewhat scattered or fragmentary form. This is especially true of the section devoted to plain and reinforced concrete, the most notable new feature of this edition and the excellent presentation of statics and the strength of materials, subjects not always adequately presented in reference books. L. E. P.

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